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AIR PUBLICATION 1354.

AIR PHOTOGRAPHY.

PART I.

ORGANIZATION AND TRAINING.

AIR MINISTRY.

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AIR PHOTOGRAPHY.

PART I.

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or the information and guidance of all concerned.

By Command of the Air Council.

W F Nicholson

MINISTRY.

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Chapter I.
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CHAPTER I.

THE PURPOSE AND VALUE OF AIR PHOTOGRAPHY.

Introductory.

1. One of the primary duties of the Royal Air Force when co-operating with the Navy or Army is reconnaissance. The use of aircraft has greatly increased the power of a commander to discover the intentions of his opponent and to keep himself informed of the movements and activities of the opposing forces. But visual observation, as a means of obtaining information, suffers from certain inherent limitations, and these are more especially marked when such observation is made from the air. It has been proved, however, that air photography is of inestimable value in compensating to a great extent for the deficiencies of the human eye, and the successful development of the air camera has vastly increased the scope of air observation.

2. During the war of 1914–18, when air photography was still in the experimental stage, it provided ample and increasing proof of its usefulness for military purposes. Since then the continued development of apparatus, equipment, and technique has resulted in considerable improvements in the quality of the photographs which can be obtained, and although much may still be done to improve the technical efficiency of the work, air photography to-day is an almost indispensable adjunct to air reconnaissance.

The Eye and the Camera.

3. In considering the relative powers of each, it is not intended to suggest that the camera is an efficient substitute for the eye, or that it can ever replace it, but a brief comparison of their capabilities will show that the air camera constitutes an invaluable means of supplementing and confirming all which can be seen by the eyes of an observer.

4. In the first place the eye has a wide field of vision, but only as a result of movement. It can cover an enormous area in a very short space of time, but if it is desired to examine any part of a landscape in detail it is necessary to concentrate the eye on the selected objects in turn and thus risk missing something which is not included in the concentrated field of vision. Further, no human observer could record or remember more than a small fraction of the details seen during the flight.

The camera lens, on the other hand, records instantaneously and permanently everything within its angle of view, and the detail on the resultant photograph can be studied at leisure and information extracted therefrom under quieter conditions than those which obtain during flight.

5. Again, the scale of the landscape seen by the eyes from an aircraft is determined by the height of the aircraft, and no adjustment can be made to the eyes to compensate for increased height. Binoculars and telescopes are artificial aids for increasing the scale, but owing to the speed of modern aircraft, and to flying conditions generally, they cannot be used satisfactorily by an observer. By the use of different lenses of varying focal lengths, however, the scale of air photographs can be altered to meet any requirements, and within certain wide limits practically any scale can be obtained irrespective of the height at which the photographs are taken.

6. The colour-correcting powers of the eyes are insufficient at high altitudes and long ranges such as those suitable for reconnaissance, with the result that the landscape is normally viewed practically in monochrome, but by placing suitable light filters in the camera lens the contrasts may be strengthened, and a view which may appear flat and dull to the eye may be recorded in the photograph with far greater contrast.

7. The view of an observer in the average ~~aircraft~~ plane is greatly restricted by portions of the fuselage ~~and the planes~~, and the only way in which he can obtain an uninterrupted view of the country below is by looking through an ~~aperture~~ in the floor. F~~or obvious reasons~~ it is impossible for him to do this continuously throughout the whole of a flight, but it is a ~~comparatively~~ simple matter to place the camera in such a position that a photograph can be taken at any given moment by merely working a lever or switch.

8. In addition to the foregoing comparisons, it must be realised that the eyes are adversely affected by fatigue, glare, ill-health, and very largely by imagination, while a purely mechanical device such as a camera is susceptible to none of these.

9. Finally, consider the difference in the task of an observer who is being flown over an occupied area at a considerable height, first without a camera, and secondly with a camera fitted in the aircraft. In the first case the observer watches the ground below until he locates some feature of an unusual character. He immediately makes a note, but in doing so temporarily removes his gaze from the object. On looking up he probably finds some difficulty in locating it again, and then while he is studying it the movement of the aircraft causes it to be obscured again by one of the planes. In

similar circumstances, but with a camera available, the observer sights an object, guides the pilot over it, and takes a photograph. By doing so he instantly obtains a permanent record of the objective, its exact location on the map, and definite confirmation of his own observations.

The Uses of Air Photography.

10. The uses of air photography for military purposes are threefold, and may be broadly classified as follows :—

(i) The provision of military information regarding the enemy and his territory.
(ii) The provision of permanent records of the results of operations.
(iii) The production of military maps.

11. *Types of military information obtainable.*—The information which can be obtained by the study of air photographs may also be divided into three classes. The general nature of each type is given below :—

(i) *Strategical.*—Signs of military activity, or the absence of it, in definite areas. Occupation of territory. Concentrations of troops. Movements of large forces. Details of communication and supply systems. Formation of camps, depôts, dumps. Demolitions in back areas.
(ii) *Tactical.*—Details of enemy works such as trenches, barbed wire defences, battery positions, machine gun posts, tank traps, aerodromes, coastal defences, etc.
(iii) *Topographical.*—The shape and extent of woods, hills, valleys and lakes. The courses of rivers, nullahs, etc., and the nature of their banks. The position of bridges and fords. The position, shape, and size of towns and villages. The nature of coast-lines, and the position of navigable channels.

12. *Records and reports of operations.*—For the purpose of obtaining records and reports of the results of operations such as air bombardments, artillery fire, etc., air photographs are more accurate than visual observation owing to the fleeting nature of the objectives. Not only can valuable information regarding the result of such attacks and the amount of damage inflicted be obtained from air photographs taken after the event, but the degree of success attained can be estimated with the minimum of delay, and with a reasonable amount of accuracy, from photographs taken during the actual operations. For this reason it is customary to include at least one aircraft fitted with an air camera in each flight engaged on day bombing operations.

13. *Production of Maps.*—(i) It is unlikely that air survey, carried out with a view to the preparation of accurate maps, will be possible over an area organised for A.A. defence, nor is this necessary when suitable maps already exist. Nevertheless, from the data obtained from air photographs, existing maps can be brought up to date and improved, and any alterations and additions necessitated during the course of operations may be made with the utmost rapidity.

(ii) Photographic mosaics are of great value for military purposes in unmapped, or badly mapped, regions, and although liable to a certain degree of distortion they are sufficiently accurate to be of the greatest assistance in planning the movements of troops through such territory.

(iii) Large-scale prints of individual air photographs, especially oblique views, are frequently very useful for familiarising unit commanders with the terrain over which they will be required to lead their men, and of which but a vague idea of the chief characteristics can be obtained from a map.

The objects to be attained in Air Photography.

14. The two primary objects which must always be aimed at in the conduct of air photography in the Royal Air Force are :—

(i) Critical definition.
(ii) Speed of production of the finished print.

15. The value of an air photograph entirely depends on the amount of useful information which can be obtained from it, and this in its turn depends very largely on the quality of the photograph itself. Photo-reading consists largely of the study of shapes and shadows, and however skilful and experienced the reader may be, it is necessary for the print to contain a sharply defined image and the maximum amount of detail if he is to succeed in extracting the greatest amount of information from it. The better the quality of the photograph, the easier and the more rapid and accurate is the work of the reader ; while a blurred and indistinct image not only increases the difficulty of his task but is also liable to cause him to make incorrect deductions.

16. The other object, speed of production of the finished print, requires little explanation. The degree of usefulness of almost every form of military information is in inverse proportion to the length of time required for it to reach its destination. A photograph which revealed the preparations for an unexpected movement on the part of the enemy would be of the utmost value to the commander and staff concerned if they received the information thus disclosed in good time, but such

a photograph would be quite useless if it was not produced until some hours after the threatened attack or retirement had taken place. It must be remembered that after the photograph has been produced by the R.A.F., a further period of time is still required before the work of interpretation can be completed by the army, and it is therefore of vital importance that the prints should be issued with the minimum of delay.

17. The photographic equipment and apparatus used by the Royal Air Force is designed with a view to assisting as far as possible in the attainment of these two objects, and it is therefore necessary that the work should be so organised, and that the training of the personnel employed on photographic duties, both on the ground and in the air, should be such that the greatest advantage is derived from the use of this equipment and apparatus, and that there should be the least possibility of failure in those operations in which the human factor predominates.

Method of Attainment.

18. The only method by which a completely efficient photographic service can be maintained is by ensuring that the personnel concerned receive a sound initial training, and that they are afterwards given constant practice in their various duties. Those concerned may be divided into two classes, i.e., the flying personnel who are responsible for actually taking the photographs from the air, and the technical photographic personnel whose duty it is to ensure that the preparation of the camera and equipment before the flight is efficiently carried out, and who are responsible for the production of the finished prints from the plates and films exposed during the flight.

19. Beyond a knowledge of the principles of camera installation, and the ability to supervise the mounting of cameras in aircraft, the flying personnel require no technical photographic knowledge, and for successful photographic flying a pilot requires no special qualifications other than those which he obtains during his training for normal flying duties. The ability to fly level on a straight course for fairly long periods, and to fly vertically over a given point on the ground, can only be attained by constant practice, but it is within the capabilities of every service pilot, provided that he is given sufficient opportunities for such practice. If, therefore, the pilot is capable of accurate flying, and the passenger possesses sufficient elementary knowledge of the mechanism to operate it successfully, the camera will do all that is required as far as the actual taking of the photograph is concerned. Nevertheless, it must be borne in mind that the cost of the photographic

materials expended in producing a set of air photographs is very small compared with the flying costs involved, and that, under war conditions, the lives of the flying personnel are an important consideration. Moreover, as has already been pointed out, the value of an air photograph depends very largely on the speed with which it can be produced, and it is very seldom either possible or justifiable to undertake a second flight, with the consequent additional cost, risk, and delay, with a view to compensating for an initial failure. It is, therefore, of vital importance that all pilots who are required to undertake photographic flights in the course of their normal duties, should be given ample practice in this type of flying, and that all observers and air gunners should be made perfectly familiar with the operation of the various types of cameras used. Squadron commanders and photography officers must ensure that the ground and air practices laid down in Chapters VIII and IX of this manual are properly carried out, and that the personnel concerned become thoroughly proficient.

20. Although the actual exposure of the plate or film is the first essential step in the production of an air photograph, it is by no means the most difficult one. The various operations which precede and follow it call for a considerable degree of technical knowledge and skill, and are fraught with many different possibilities of failure. The photographic personnel responsible for these operations receive their initial training at the School of Photography, and in order to pass the course successfully they are required to attain a high standard of knowledge and proficiency. But practice and experience are as essential for thorough proficiency as theoretical knowledge, and unless the officers and airmen concerned are given ample opportunities for carrying out their technical duties after posting to service units, the high standard of work required cannot be maintained. At times when the amount of photographic work being carried out by the unit is small, every effort should be made to provide frequent practice tests for airman photographers.

21. As regards the two main objects to be attained, critical definition depends chiefly on the care with which the cameras, equipment, and apparatus are adjusted and used, and on the skill with which the various operations such as loading magazines, developing plates, printing, enlarging, etc., are carried out. It is, therefore, primarily a matter of individual proficiency. Speed of production of the finished print is more a matter of organisation, and under no circumstances can it be secured by haphazard methods of working. It is the duty of every officer in charge of a unit photographic section to be constantly on the watch for means of improving the organisation of the work, and to ensure that every operation, including

practice tasks and those of a comparatively unimportant nature, is carried out with the minimum of delay. He should at the same time be careful that the highest possible standard of work is maintained, and should never pass results which fail to reach this, or neglect to investigate reasons for such failures.

22. Chapter III of Part I of this manual contains the general instructions for the organisation of photography in a unit. Part II of the Manual includes full details regarding the correct methods of carrying out the various photographic processes. Both of these should be carefully studied and the provisions invariably adhered to by all those actively concerned.

Chapter II.
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CHAPTER II.

GENERAL ORGANISATION.

Chain of responsibility.

1. The chain of responsibility for the organisation of air photography is as follows :—

(i) *Air Ministry.*—All questions of policy and organisation in connection with air photography are dealt with by the Directorate of Organisation and Staff Duties in the Department of the Chief of the Air Staff. This directorate is responsible, after consultation when necessary with the Commandant, School of Photography, for the issue of all orders and instructions required for the efficient performance of photographic work in the Royal Air Force. Any special orders or instructions of a purely operational nature which involve the execution of photographic duties are issued when necessary by the Directorate of Operations and Intelligence.

(ii) *Areas and independent commands.*—An officer, designated the " area photography officer," is appointed to the staff of each air officer commanding an area or independent command, and is responsible for the organisation of air photography in the area or command.

(iii) *Groups.*—An officer, designated the " group photography officer," is appointed to the staff of each group commander whose command includes units which carry out air photography. The officer is responsible for the organisation of air photography in the group.

(iv) *Units.*—Every officer commanding a squadron, or independent unit, which is required to carry out air photography, will appoint an officer of the general duties branch to carry out the duties of unit photography officer. Officers are posted by the Air Ministry for such duties, and are shown in the Air Force list with " ph " after their names.

It is the duty of all unit and formation commanders to organise, in conjunction with their photography officers, the photographic work of the unit, or formation under their command, on the lines laid down in this Manual, and with any other instructions which may be issued from time to time. This does not, however, absolve commanders from improvising the best arrangements possible when the authorised means are not available.

Responsibility for New Design.

2. Photographic research and experimental work in connection with new design of cameras and photographic equipment is carried out at the Royal Aircraft Establishment, under the orders of the Director of Technical Development, in the Department of the Air Member for Supply and Research. This directorate is responsible for all experimental work and design up to and including the issue of type trial models of new apparatus.

3. Photography officers and C.Os. of units, who, through practical experience, consider that any modifications or improvements could be made to existing designs of cameras and photographic equipment with a view to fulfilling service requirements, should submit their suggestions through the usual channels.

Responsibility for Supply.

4. The Director of Equipment, under the Air Member for Supply and Research, is responsible for the provision of photographic equipment, with the exception of permanent buildings and constructional fittings supplied by the Directorate of Works and Buildings.

5. The supply of cameras and photographic equipment to units will be made in accordance with the provisions of Air Publication 830.

Responsibility for Repairs.

6. C.Os. of units which hold cameras and photographic equipment on charge are responsible that all such articles of equipment which become unserviceable are dealt with in accordance with the regulations.

7. The procedure for effecting repairs is laid down in Air Publication 830, Chapter 22, Section 3, and in Air Ministry Weekly Order 442 of 1925.

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CHAPTER III.

ORGANISATION OF PHOTOGRAPHY IN A UNIT.

Photographic Sections.

1. Photographic sections are organised in time of peace on either a squadron or station basis. The photographic section of a squadron or an independent unit may be organised either as a permanent or as a mobile unit, according to circumstances and to the type of accommodation available.

2. *Permanent Sections.*—(i) At all permanent stations, at home and abroad, normally occupied by one or more squadrons which carry out air photography, a specially designed building will be provided for photographic purposes. Such a building will include dark room, work room, office, and storage accommodation, and should, under no circumstances, be used for any other purpose than that for which it is designed.

(ii) In certain formations, photographic sections will be organised on a station basis. Where this is done, all ground work in connection with air photography will be carried out at the station photographic section under the control of the station photography officer. This section, which will occupy permanent accommodation, will take the place of squadron sections for all normal purposes. The station photography officer will usually be an officer posted to the station headquarters for this purpose, but in the event of such an officer not being available, this duty will be carried out by one of the photography officers of the squadrons occupying the station at the time. The organisation of station photographic sections should be in every way similar to that of squadron sections, and, except where it is otherwise stated, the instructions contained in this chapter will apply equally to both.

3. *Mobile Sections.*—(i) All squadrons and independent units which are organised on a mobile basis, and which are required to carry out air photography as part of their normal service employment, are equipped with a photographic lorry and trailer. These vehicles provide adequate dark room accommodation for all normal purposes, and are also capable of transporting the entire squadron photographic equipment. They thus constitute a satisfactory means of carrying out the necessary ground work when the squadron is operating away

from a permanent base, either in course of training or on active service, or on occasions when no other more suitable accommodation is available.

(ii) When the squadron is situated at an aerodrome where a permanent building is available, the photographic lorry and trailer should not be used for normal work. As, however, the working space in these vehicles is considerably more restricted than that afforded by a specially constructed building, the personnel of the section must be given adequate practice in working in them, in order that no loss of efficiency may result when they are brought into use.

(iii) Squadron photography officers should be prepared, when operating in the field, to adapt local facilities to their needs, and to establish dark-rooms, printing rooms, etc., in any premises which may be available and which lend themselves to this purpose. In selecting accommodation for photographic purposes, attention should be paid to the following factors:—Temperature, Ventilation, Humidity, Water Supply, and the ease with which the rooms may be made light-proof.

4. *Allocation of Photographic Duties.*—The allocation to officers of duties in connection with air photography are set out in Appendix III.

Employment of Personnel.

5. In allocating duties to the personnel of the photographic section, special care should be taken to avoid any large degree of specialization. It will be found that many airman photographers are apt to be more proficient in one branch of their work than in another, and to show a marked preference for that particular type of work. Thus, an airman who excels at plate development, but whose printing and titling is poor, is liable, owing to his proficiency in, and liking for, such work, to be continuously employed on developing. This state of affairs must be carefully guarded against, for if specialization is permitted, when cases of sickness or absence occur the general efficiency of the section as a whole will be seriously affected. The object to be aimed at is to attain a high standard of proficiency throughout the section in all branches of the work, and with this end in view the duties should be arranged so that the nature of each man's employment is frequently changed, and that airmen are given constant practice in those duties in which they show the least proficiency.

6. Speed of production of the finished prints being one of the primary essentials in photographic work in the field, it is the duty of the unit photography officer to devote constant thought to the problem of how this may be attained. The actual periods of time required for the various chemical

processes cannot be altered, and the technical perfection of the work must never be sacrificed for increased speed, but there are other factors which have a great bearing on the time taken to procure a given result. The greatest delay occurs in passing plates, printing paper and materials from one operator to another between the various processes, and every minute, or every second, which can be saved by improving the organization is of value. An efficiently organized section is one in which every man, every piece of equipment, and every piece of material, is in the right place at the right time, so that the work proceeds at the maximum speed and with the minimum confusion.

7. Personnel employed in dark rooms must be relieved at frequent intervals. The restricted means of ventilation, which is due to the necessity for keeping the room light-proof, causes the temperature to rise and the air to become foul. This gives rise to headaches and other adverse effects to the health of the operators if they are kept working too long under such conditions. The longest period during which an airman working at high pressure can remain in a dark room without discomfort is approximately 2 hours. This varies considerably with the climatic conditions, and is much less in hot countries. Every opportunity must be taken to open all doors and windows in the dark room to admit fresh air.

Position of Photographic Section.

8. In peace time, at a station where a permanent building is erected for the use of the photgraphic section, the site will be fixed after consultation with the Directorate of Works and Buildings. When conditions are such that temporary accommodation has to be selected, or the photographic lorry and trailer employed, the decision as to the most suitable site will rest with the C.O. and the unit photography officer.

9. The two primary factors in determining the most suitable location for the section are as follows :—

(i) Proximity to the aerodrome and hangars.
(ii) Adequate water supply.

10. When there is any doubt as to which of two or more possible sites should be selected, the relative advantages of each under (i) and (ii) must be compared, and the one which affords the greatest saving of time and labour in communication and transport should be chosen.

Storage of Cameras and Equipment.

11. (i) All cameras and equipment should be kept by the photographic section. Cameras not required for use may be kept in unit stores. Cameras should not be left in charge of flights.

(ii) Cameras, and camera fittings, should be kept in the storage cases in which they are issued.

(iii) Cameras, camera mountings, and mechanical equipment generally should be stored separately from chemicals and photographic apparatus.

(iv) Cameras and equipment should be returned to the section as soon as possible after use in the air, and in any case before the end of the day's work.

(v) In every photographic section a register should be kept showing particulars of all cameras and equipment on charge and details of all daily issues and returns to and from flights.

(vi) Cameras and equipment must be kept clean and free from dust, and working parts should be oiled and tested at regular intervals even when not in use.

Installation of Cameras and Equipment in Aircraft.

12. The King's Regulations and Air Council Instructions, 1928, para. 702, clause 8, state that the rigger, or senior rigger, is responsible that equipment is installed in such a manner as not to prejudice the safety of the aircraft. Nevertheless, the actual work of fitting, and removing, photographic equipment in aircraft is the duty of the personnel of the photographic section.

13. All cameras and equipment should be tested before leaving the section in order to ensure that they are in proper working order. When such equipment is required for use in the air, it will be conveyed to, and fitted in the aircraft by a photographer detailed for the purpose. Having installed the camera and fittings satisfactorily, the airman concerned should invariably test the mechanism again before the aircraft takes off. This test should consist of carrying out several complete cycles of operations with the camera, and should be performed with the mechanism set first for hand, and then for power operation. The latter test should be carried out while the engine is being run up. Special care must be taken to ensure that the flexible drive from the windmill does not touch either the camera or the camera mounting at any point other than at the bayonet joint, and that all bowden cables are working freely in their sheaths.

14. Arrangements should be made for a photographer from the section to be available whenever an aircraft which has been carrying out air photography returns. It is desirable that the airman who fitted the camera before the commencement of the flight should be detailed for this duty. As soon as possible after the aircraft has landed he should take charge of the exposed magazines and return them to the photographic section. He should also obtain a brief report from the operator

regarding the working of the camera. If this has been satisfactory and the camera is not required for further work in the air he should remove it from the aircraft, and return it together with the camera mounting and other fittings, to the section. In the event of any failure or faulty working being reported, he should carry out a brief inspection of the equipment before removing it from the aircraft, with a view to ascertaining if such failure has been due to faulty installation. If this does not appear to be the case, he should return the camera at once to the section for a thorough examination.

Repair of Cameras and Equipment.

15. Only minor repairs and adjustments to cameras and equipment may be carried out by the personnel of the photographic section. Photographers are not trained as camera repairers, and should not be permitted to attempt such work. When a camera becomes unserviceable it should be returned to the appropriate repair depôt as soon as possible and a replacement obtained in the usual manner. The relevant procedure is laid down in Air Publication 830, Chapter 22, Section 3, and in Air Ministry Weekly Order 442 of 1925.

16. As a general guide, the following minor repairs to the types of cameras specified are the only ones which should be undertaken by a unit photographic section :—

(i) " *P.7* " *Camera.*—Fitting of :—

Complete Shutter.
Return Spring.
Spring on Finger.
Guillotine Spring.
Spring for Intermittent Wheel.
Shutter Catch.
Magazine Catch.

(ii) " *P.14* " *and* " *P.18* " *Cameras.*—Fitting of :—Daylight Loading Slide.

Note.—Under no circumstances should any attempt be made to effect repairs to any part of the shutter, plate changing, or gearbox mechanisms in any of the above cameras.

(iii) " *F.8* " *Camera.*—This camera is built up on the unit system, each unit being interchangeable with the corresponding unit of any camera of similar type. All bearing and friction surfaces of the moving parts should be frequently oiled, but no repairs of any kind may be attempted. A component containing a broken or unserviceable part will be replaced by a serviceable component drawn from stores. and the defective component sent for examination and repair.

Storage of Sensitive Materials.

17. Photographic plates, films, and printing papers should be carefully stored under the most favourable conditions obtainable in order that they may be maintained in good condition.

18. Whenever possible such materials should be stored in a cupboard in a dry, well-ventilated room such as the daylight work room, and it is important that they should be kept remote from the place where the chemicals are made up. Boxes of plates, and packets of bromide paper should invariably be stored on edge and never stacked flat one upon the other. If the latter practice is permitted, the pressure on the material at the bottom will result in " stress " marks and render it unfit for use.

19. In order to avoid the possibility of wastage of plates when opening a box from which the entire contents are not immediately required, the following procedure should be adopted. The outside paper wrapper should be scored through the centre on all four sides so that it may be removed in two sections. When the required number of plates have been withdrawn the two halves of the wrapper should be replaced over the box and joined round the centre with paper and paste, or with passe-partout binding strips. The contents will thus be protected from accidental exposure to light, and the reference as to the type of plates retained.

20. As soon as a packet of printing paper has been opened the whole of the contents should be transferred to the special light-tight bromide paper storage boxes, each box being labelled to show the grade of paper it contains. This will prevent numerous boxes being opened in error and left partially depleted.

21. Should the premises in which the sensitive materials are stored be at all damp, provision should be made for raising the cupboard containing them above the level of the floor and for keeping it from contact with the walls.

Storage of Chemicals.

22. Most of the chemicals employed in photography will remain in good condition for long periods if properly stored. The instructions contained in paras. 17–21, regarding the storage of sensitive materials, apply equally to the storage of chemicals, except that the latter must always be kept separately

from the former. Attention will also be paid to the following points :—

(i) All bottles containing chemicals should be kept well stoppered or corked, as the case may be. This is of vital importance with chemicals which oxidise readily, or are of a deliquescent nature.

(ii) Bottles containing chemicals in crystals or in powdered form must not be allowed to stand about in dark rooms or work rooms.

(iii) All chemicals should be kept in a locked cupboard, the key of which should be held by the N.C.O. in charge of the section. The N.C.O. in charge will issue chemicals as required for the preparation of solutions and any partially emptied bottles should be returned to him immediately after the required amount of the contents has been used.

(iv) The N.C.O. in charge should regulate the issue of chemicals in such a manner as to ensure that those which have been longest in stock are used up before new supplies are brought into use.

Marking, Registration, Filing, Custody, and Storage of Negatives.

23. The regulations governing the marking, registration, filing, custody, and storage of both plate and film negatives are contained in Air Ministry Weekly Order 526 of 1926 as amended by 381 and 463 of 1927 and 516 of 1928.

Negative Card Index.

24. In addition to the five registers mentioned in Air Ministry Weekly Order 526 of 1926, para. 5 (iii), a card system of indexing air negatives according to the area on the map covered by each should be kept by every photographic section.

25. The object of this system is to keep a series of cards each of which represents a fixed and definite area on the map, or maps, in use. Every air negative which covers the whole or a portion of any one of these areas is entered on the appropriate card, the reference numbers of the negatives and the dates on which they were taken being entered in chronological order in the columns provided.

26. Where the ordinary gridded maps are available, the application of the system is simple, a separate card being made out either for each map sheet, or for each lettered 10 kilometre square, or even for each numbered sub-square. The decision as to which of these divisions is to be employed will depend

on circumstances and on the type of squadron taking the photographs. In the case of an army co-operation squadron which takes large numbers of photographs over a limited area, it will normally be necessary to keep a separate card for each numbered sub-square, but in the case of a bombing squadron working over a much larger area, the division for each card may be increased accordingly.

27. When gridded maps are not available, the index should be divided up in the most convenient manner, the main divisions normally being the separate map sheets. A specimen negative index card is shown in the following example :—

Map Number :—XIII B.				*Square " K "* Sub-Square *78*			
Negative No.	Date.	Negative No.	Date.	Negative No.	Date	Negative No.	Date.
B. 976 V.	*21.6.26*						
C. 72 V.	*15.7.26*						
C. 108 V.	*16.7.26*						
C. 502 V.	*3.9.26*						
K. 1237 FV.	*11.2.27*						
K. 4593 FV.	*13.5.27*						

28. A similar system should be adopted for ground negatives, cards being allotted to the various types of subject as is most convenient.

29. The Negative Registers and the Negative Card Indices together provide the most rapid and accurate means of tracing any negative required, and the information contained in each is complementary to that contained in the other.

Plate and Paper Consumption Record.

30. In peace-time a record should invariably be kept showing the supplies of sensitive materials received and the quantity expended on each task. Any suitable book may be used for this purpose, the pages being ruled as shown in the specimen below. The records of plates, films, and paper should be kept on separate pages.

31. All boxes of plates, rolls of film, and packets of printing paper should be numbered as they are received in the photographic section. These reference numbers, together with the date of receipt, will be entered in the " IN " columns on the appropriate pages. The quantity expended on each particular occasion, the purpose for which it was used, and the date

should be entered in the " OUT " columns. A specimen page of this book is shown below :—

PAPER.

Contrasty 1/1. Ref. No. 777.

IN		OUT			
Date.	Gross Box No.	Date.	Gross Box No.	No. of Sheets.	Purpose for which required.
1927 *May 1st*	*10 to 15*	*1927* *May 5th*	*10*	*36*	*F/O. Jones—overlaps.*
		,, *5th*	*10*	*36*	,, *Smith—overlaps.*
		,, *6th*	*10*	*18*	,, *Smith—pin-points.*
		,, *6th*	*10*	*18*	,, *Brown—pin-points.*
		,, *8th*	*10*	*36*	,, *Brown—overlaps.*
		,, *9th*	*11*	*36*	*Mosaic of aerodrome.*
		,, *14th*	*11*	*18*	*F/O. Green—pin-points.*

32. This record serves the following purposes :—

(i) It forms a check on the work of the section, and when examined in conjunction with the quality of the results produced, provides a record of the general standard of efficiency of the personnel in the various technical processes.

(ii) It prevents waste of sensitive materials, and enables any excessive consumption of stocks to be traced.

(iii) It provides a valuable record of information on which the unit photography officer can base his estimate of the quantity of materials required for any particular period, or purpose.

Chapter IV.
of
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CHAPTER IV.

FLYING FOR PHOTOGRAPHIC MOSAICS AND AIR SURVEY.

General.

1. R.A.F. units which carry out photography, and the kind of photography normally undertaken by those units are enumerated below :—

(i) *Army Co-operation Squadrons.*—Obliques and verticals.
(ii) *Day Bombing Squadrons.*—Verticals ; may be required to take obliques.
(iii) *Night Bombing Squadrons.*—Verticals ; for recording practice bombing and training purposes only.
(iv) Flying Boats (C.R. Flights)—Obliques.
(v) Float Planes (C.R. Flights).—Verticals and obliques.
(vi) Fleet Reconnaissance.—Obliques and verticals.
(vii) Fleet Spotter.—Obliques and verticals.

Pilots and Observers.

2. To obtain the best results in all types of air photography, it is necessary for all personnel employed on photographic flying to have a good working knowledge of the subject, including the fitting and operation of air cameras in Service use. Pilots should fly as observers and operate the photographic equipment in order to appreciate difficulties ; this will lead to closer co-operation in the air and better work will result. Some form of intercommunication is essential. Electric telephones are the most satisfactory but speaking tubes may be used with success. Pilots must be able to fly straight and level for long periods and must exercise patience at seemingly unnecessary delay on the part of the observer or camera operator. Aircraft should not be stunted or violently side-slipped as the photographic equipment carried is liable to be damaged. Pilots should be familiar with the type of aircraft to be flown, as their minds must be free from any feeling of strangeness so that they may be able to concentrate on the many simultaneous requirements of a good photographic flight.

OBLIQUE PHOTOGRAPHS.

3. These may be taken with a hand-held camera, with a camera suspended in shock absorber, or other form of mounting on the gun ring, or by means of a camera held in a standard mounting in the aircraft and inclined at a fixed angle from the vertical. The height and distance between the aircraft and the objective cannot be laid down definitely owing to the varying types of obliques which may be required. A suitable position from which to take the photographs must first be selected, having regard to the subject and to the position of the sun. The engine should be throttled right down and the aircraft put into as slow a glide as is compatible with safety. The observer, by means of a pre-arranged signal, should inform the pilot as soon as the exposure has been made, to enable the latter to open his throttle and carry on with as little delay as possible. If the nature of the country does not permit the throttling down of the engine, the camera should be suspended by means of the shock absorber mounting on the gun ring or used in the standard mounting.

Overlapping and stereo obliques with one camera.

4. The following is an outline of the procedure which should be adopted for taking overlapping obliques :—

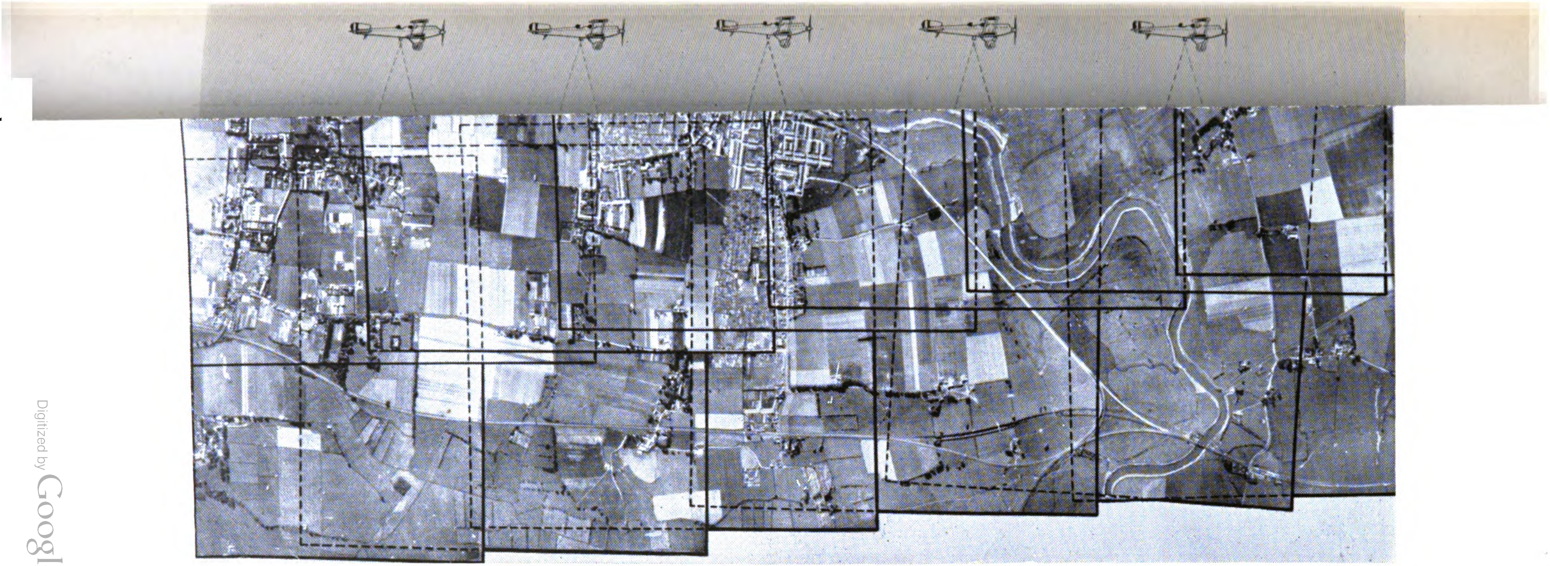
Before commencing the flight, it is necessary to decide at what angle from the horizontal the camera will be held. If the standard mounting is used, this will be known. If the camera is hand-held, then a suitable guide mark on the trailing edge of the wing is advisable. If an automatically controlled camera is used, then the pilot will fly straight down a pre-arranged track, exposing at suitable intervals, which will depend on the ground speed, height, inclination of camera and focal length of the lens. If the camera is of the type which requires plates to be changed by hand, then, probably, it will be necessary for the pilot to circle round after each exposure before approaching the next selected position.

5. Stereo obliques may be obtained by the same procedure as outlined above by exposing from two points close together on the pre-arranged track, care being taken to maintain the same angle of inclination of the camera. This is simplified by means of the automatic camera, when exposures can be made in rapid succession.

VERTICAL PHOTOGRAPHS.

6. These may be required for :—

(i) Pin-points.
(ii) Making mosaics.
(iii) Survey purposes.



CHAPTER IV, FIG. I.—Example of mosaic with 60 % longitudinal, and 30 % lateral overlap.

Pin-points.

7. In this case, the pilot is primarily concerned with flying the aircraft so that it will pass vertically over the objective. It is, therefore, comparable to bombing an objective, and the aircraft should be handled during the approach in exactly the same way. On arriving at the selected height and before approaching the objective, the pilot should set his throttle and tail adjusting gear so as to fly straight and level at a fixed speed and to enable the camera to be levelled in the mounting. The exposure should be made when vertically over the objective. The aircraft must be level laterally and flying at the same fore-and-aft angle as when the camera was levelled.

Mosaic Photographs.

8. The facility with which photographic mosaics can be made is largely governed by the aspect of the country which is to be photographed. If reliable maps are available showing well-defined objects which can be taken as sighting points, the work is comparatively simple. If, however, the area is composed of open tracts of country, forest land, or desert with no obvious sighting points, considerable difficulty will be experienced.

9. The general method of procedure in making mosaics is to obtain a series of strips of overlapping photographs, these also overlapping laterally. The lateral overlap is determined by the distance between parallel "runs," the amount or percentage of lateral overlap to be aimed at is therefore to some extent dependent on the experience and skill of the pilot, but as a general rule, 30 per cent. may be taken as a good average. The longitudinal overlap is usually determined by the requirements for stereoscopic examination of the prints, for this purpose an overlap of 60 per cent. is required, and this figure is, therefore, taken as the standard longitudinal overlap in the R.A.F. Further, if for any reason one exposure of the series fails, the resulting photographic strip is still continuous. A simple 60 per cent. longitudinal overlap with a lateral overlap of 30 per cent. is illustrated in fig. 1.

10. In the remaining paragraphs dealing with mosaics it is assumed that the standard Service equipment only is available, and that no personnel has been specially trained. The ideal mosaic is one which is taken under the following conditions :—

(i) Running straight.
(ii) With correct overlap fore-and-aft and laterally.
(iii) With no tilt in any direction.
(iv) At a constant height.

It is, therefore, necessary to determine how these conditions can best be obtained.

11. *Running straight.*—It is essential to maintain a straight course while carrying out the runs over the mosaic area. The methods of doing this with standard Service equipment are as follows :—

(i) By means of an accurate compass.

(ii) By flying straight at some part of a distant cloud or object.

(iii) By keeping the shadow of some object on the aircraft in a constant position.

(iv) By following a straight line, such as a railway, and keeping a mark on the leading or trailing edge of the bottom plane in line with the railway.

(v) By observing some object on the ground and flying towards it.

Flying on a compass course (corrected for wind) in conjunction with some definite object or cloud is found to give the most satisfactory results.

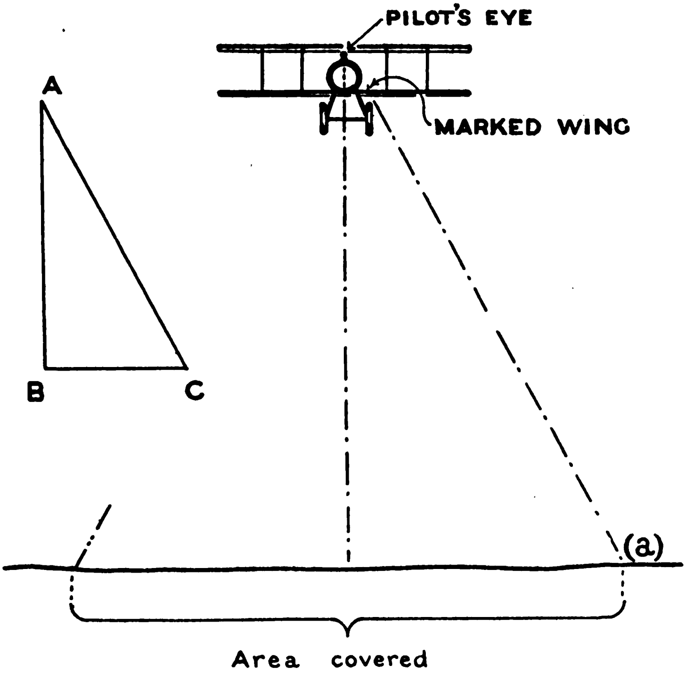
12. *Correct Overlap Fore-and-aft and Laterally.*—In order to obtain an overlap, it will be necessary first to decide upon the height from which the photographs are to be taken. Any special scale required can be worked out by means of suitable formulae. The time interval between exposures to obtain the required fore-and-aft overlap can be calculated if the air speed of the aircraft, wind speed, size of plate, and focal length of lens are known. This calculation can be checked by the following method :—

Measure the distance between two points on a map ; calculate the number of exposures with correct overlap required to cover this distance, and, when in the air, find the time taken to fly between the two points. This time, divided by the number of exposures with correct overlap, will give the time interval.

13. The lateral overlap presents more difficulty. In any form of mosaic work it will be essential to identify the starting points on the ground. If a suitable map of the area is available, work out by means of formulae the distance between each run for the overlap desired and then select suitable points at the proper distance apart on the map which may be identified easily from the air. If each run is commenced over one of these points and the aircraft flown on a parallel course each time, lateral overlap will be correct.

14. If a map of the area is not available, the overlap may be obtained by means of the "wing marking" method (see fig. 2). The marks are painted on the upper surface of both bottom planes in a position on the leading or trailing edges, where the pilot can see them. The marks are so placed that

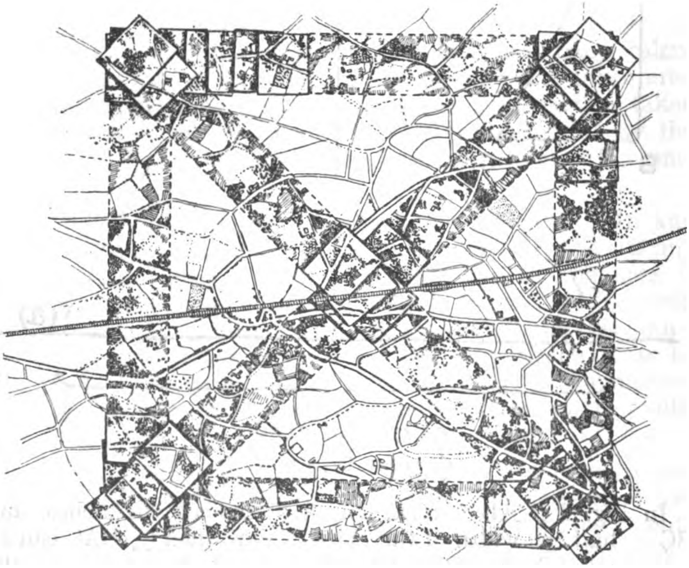
when the pilot looks over the side he can see the mark travelling over the ground as he is exposing the first run. Since the position of the mark is calculated for the focal length of the lens in use and for the type of aircraft, it indicates the edge of the area covered during the run; it is obvious that the next run must be over the line traversed by the mark so as to obtain a 30 per cent. lateral overlap. The diagram illustrates this point. A line from the pilot's eye to the marked wing is produced and cuts the ground at (*a*). Suppose (*a*) to be a canal parallel to the original course, then the next run must be over the canal. The process is continued until the area is covered. "Bumps" naturally increase the difficulties, but this method may be employed with success for an area containing easily recognisable objects; it is obviously unsuited to every type of country. The correct position for the wing marking for the type of aircraft and focal length of the lens used, can be found as follows:—



CHAPTER IV, FIG. 2.

In Fig. 2 if AB = focal length of the lens in inches, and BC = half the width of the plate or film, then ∟ BAC can be calculated. Now in the aircraft if point A is taken as the approximate position of the pilot's head in the cockpit, then the point where line AC produced cuts the lower plane will give the correct position for the mark, and this can be determined by direct measurement as ∟ BAC is known.

15. Another method of obtaining a lateral overlap when a map of the area is not available is by means of the "strip" method. Having identified the area to be photographed by means of air reconnaissance, decide upon the direction and length of the run lines, having regard to the probable accuracy of the flying in relation to the overlap. Now take a line of photographs, flying along the starting points of the proposed run lines, i.e., if the run lines are to be East and West, then take a strip of photographs running North and South. Take a second line of photographs along the finishing points of the proposed run lines. These points should be selected where conspicuous natural features are available. If possible, also take one or more runs parallel to the proposed run lines to act as "tie" strips for the cross strips (see Fig. 3). If these strips are suitably reduced and mounted, the runs can be marked, indicating the actual starting and finishing points and the approximate tracks to be made good, and a copy given to the pilot making the mosaic. Even over apparently featureless country it will be found possible to identify some suitable points. It is frequently possible to use a combination of these methods.



Chapter IV, Fig. 3.—Skeleton of Mosaic.

16. *No tilt in any direction.*—Tilt may be either fore-and-aft or lateral, and may be due to incorrect levelling of the camera in the mounting or to errors in flying.

Levelling the camera.—Upon reaching the pre-determined height, the aircraft must be throttled down to fly straight and level and the tail adjusting gear set. In types of aircraft which have two or more petrol tanks, it is essential to use the tank most nearly over the centre of gravity during the actual runs, otherwise the trim will be constantly changing. The camera should then be adjusted so that the spirit levels show it to be pointing vertically downwards for the particular trim of the aircraft. It is of the utmost importance that this trim should not be altered during the runs. If it becomes necessary to adjust the throttle position during the run, the air speed or the fore-and-aft trim are altered, and it may be necessary to re-level the camera.

17. Any tilt obtained which is not due to the incorrect levelling of the camera must be caused by a temporary displacement of the aircraft either fore-and-aft or laterally. If the rules for " Running straight " laid down in para. 11 above are observed, the pilot should notice any rise or fall of the nose of the aircraft and check it instantly. Lateral displacement must be checked by a quick glance along the wings to ensure that they are horizontal. Marks on the outer struts can also be used. These will indicate the approximate correct position of the horizon from the pilot's cockpit. It is of great importance that the rigging of the aircraft should be as accurate as possible, but should there be a tendency to fly one wing low, it is better to correct this by means of the camera levelling gear than to attempt correction by means of the control column.

18. *At a constant height.*—It will be obvious that all the photographs of one mosaic should be taken at a constant height, otherwise the difficulties of the ground staff will be considerably increased and in some circumstances the results will be useless. If a strut thermometer is available, the absolute height can be calculated, but for average service conditions the altimeter reading will be satisfactory. The pilot should take particular care to ensure that each run is commenced at the same height and that the aircraft is not climbing or losing height during the run. The air speed indicator and engine revolution counter are also of assistance in maintaining a constant height.

19. In the preceding paragraphs of this Chapter, the four essential requirements for a successful mosaic flight have been dealt with in some detail. The general procedure recommended

in order to realise these requirements may be classified under two headings :—

(i) Mosaics undertaken by pilot alone or by pilot and camera operator.

(ii) Mosaics undertaken by pilot and observer.

20. *Mosaic undertaken by Pilot and Camera Operator.**—(i) *On the ground.*—(*a*) Ascertain definitely what photographs are required ; work out the number of exposures necessary, having regard to the scale, height, focal length of the lens and the overlap.

(*b*) Find the strength and direction of the wind, and if a map is available, arrange the run lines accordingly. The best results are usually obtained by flying into wind and parallel to the longer side of the area.

(*c*) Work out the time interval for the fore-and-aft overlap.

(*d*) Work out the compass course for the runs.

(*e*) Work out the " radius of action " calculation, and the time available for photography.

(*f*) Work out the drift for the compass course to be used and set the camera turntable accordingly.

(*g*) See that the camera is correctly mounted and tested, shutter slit adjusted, etc.

(*h*) When more than one magazine is used, see that they are numbered and properly stowed in the aircraft.

(*i*) When an overlap other than a straight line is being taken, decide what method is to be adopted for negotiating corners. If the bends are so acute that it is impossible to keep over the objective by means of flat turns, thus keeping the camera level, the best method is to make the exposures up to the bend, then turn away and come back over the bend, heading in the new direction, the operator starting exposures again at the spot where he had previously left off.

(ii) *In the Air : Duties of Pilot.*—(*a*) Having reached the pre-determined height, set the radiator shutters, adjust the throttle and tail gear to fly level, and when satisfied that these adjustments are correct, instruct the operator to level up the camera.

(*b*) Proceed to the starting point of the first run and carry out the procedure which can be applied most satisfactorily in the circumstances (see paras. 11 to 18). The pilot will have to get over the starting point without any assistance, and this requires practice. He should fly to such a position that he is well away from the area to be photographed, on that side from which the exposures will be commenced, and in line with points situated on the first " run line." He should now fly on the pre-determined compass course, checking his position with the assistance of a map, if available.

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* *Note.*—In this paragraph it is assumed that the camera operator if carried, will take no part in the direction of the aircraft, but will be responsible for the correct working of the camera as and when required by the pilot.

(*c*) Inform the camera operator when to make exposures. (*Note.*—It will be advisable to make exposures in one direction only.)

Duties of Camera Operator.—(*a*) When the pilot indicates that the aircraft is flying level at the correct height, level the camera.

(*b*) See that the shutter is set, magazine (*s*) in position, control box set at the correct time interval, and turnable adjusted for drift.

(*c*) Work the camera as directed by pilot.

21. *Mosaic undertaken by Pilot and Observer.*—(i) *On the Ground.*—(*a*) Ascertain definitely what photographs are required. Work out the number of exposures necessary, having regard to the scale, the height, the focal length of the lens and the overlap.

(*b*) If the strength and direction of the wind are to be ascertained on the ground, then arrange the run lines accordingly ; work out the fore-and-aft time interval for the overlap required, and the compass course for the runs, allowing for wind.

(*c*) If the strength and direction of the wind are to be found by navigational methods in the air, then work out the run lines and the compass course uncorrected for wind speed and direction.

(*d*) Work out the " radius of action " calculation and the time available for work over the area.

(*e*) See that the camera is correctly mounted and tested, shutter slit adjusted, etc.

(*f*) When more than one magazine is used, see that they are numbered.

(*g*) See that any additional magazines are correctly stowed in the aircraft.

(ii) *In the Air : Duties of Pilot.*—(*a*) Having reached the pre-determined height, set the radiator shutters, adjust the throttle and tail gear to fly level and when satisfied that the adjustments are correct, notify the observer that he may level up the camera.

(*b*) If the wind speed and direction have not been ascertained, carry out the necessary procedure to obtain them in co-operation with the observer.

(*c*) Obtain from the observer the compass course for the runs to make good the necessary track or tracks.

(*d*) Proceed to the starting point of the first run and with the assistance of the observer carry out the procedure which can be applied most satisfactorily in the circumstances (see paras. 11 to 18).

Duties of Observer.—(*a*) When the pilot indicates that the aircraft is flying level at the correct height, level the camera.

(*b*) Carry out the procedure for obtaining the wind speed and direction, if this has not been done on the ground.

(*c*) Calculate the time interval for the fore-and-aft overlap, if this has not been done on the ground, and set the control box accordingly.

(*d*) Work out the compass course or courses for the runs, having regard to the wind speed and direction, and inform the pilot.

(*e*) Calculate the drift and set the turntable accordingly.

(*f*) See that the shutter is set, magazines in position, etc.

(*g*) Assist the pilot to fly over the pin-point for the commencement of the runs.

(*h*) Take all the photographs.

22. The procedure given in para. 20, " Mosaic undertaken by pilot alone, or by pilot and camera operator," should only be followed when it is impossible to employ an observer. The actual allocation of duties between the pilot and observer must obviously vary with different types of aircraft, but the following may be taken as a useful guide. The pilot should be able to give as much attention as possible to keeping the aircraft at a constant height, on an accurate course and on a level keel. He cannot be continually looking at the ground if this is to be done. On approaching the starting point of a run, the pilot should concentrate on keeping the compass course correct and the aircraft level, leaving the detailed directions for getting over the objective to the observer, who will instruct him to turn left or right if necessary. Once the run has been commenced, the pilot should continue to fly straight and level without reference to the ground, and receive any correction from the observer, who will inform him as soon as the run is concluded, and mark on his map the actual position of the termination of the run. The errors due to incorrect estimation of wind speed or direction may be corrected on subsequent runs.

Flying for Survey.

23. The same general procedure applies to photographic flights for survey as for ordinary Service mosaic work, but a much greater degree of accuracy is required. It will be necessary to have a specially trained pilot working in close

co-operation with a trained observer, using additional equipment, and with a special layout of the vital instruments in the aircraft. The degree of accuracy essential will naturally vary with the type of work to be undertaken by the ground staff in producing the finished mosaic or map, but it must be borne in mind that if a high standard of work is obtained by the flying personnel, the work of the ground staff will be greatly facilitated and also fewer ground control points may be used. Generally speaking, the following is the standard of accuracy called for in this type of work :—

(i) To keep the aircraft to within 25 feet of a constant height.
(ii) To take photographs with less than two degrees of tilt fore-and-aft and laterally.
(iii) To take strips of photographs with a correct fore-and-aft overlap of 60 per cent. and a lateral overlap of 10 per cent.

24. In order to fly the aircraft without varying the height more than 25 feet, it is essential to have a stable machine which can be adjusted to fly "hands off," with an open scale altimeter, a fine adjustment of the throttle, and a strut thermometer for calculating the true height. The elimination of tilt will largely depend on the ability of the pilot, but may be assisted by means of an accurate inclinometer used in conjunction with a statoscope. To maintain a fore-and-aft overlap of 60 per cent. on a series of runs calls for care on the part of the observer in his calculations of the wind speed and direction. The lateral overlap can only be maintained at 10 per cent. firstly by accurate calculation, and secondly by extreme accuracy in flying on the part of the pilot, combined with careful correction from the observer. An aperiodic compass must be used, and, if possible, a camera aiming sight, and a gyro. rudder control. For survey purposes it is necessary that the camera should give critical definition and must show the "collimation" marks in order to define the optical centre, also the focal length of the lens must be calibrated. The film should show the height, the time of exposure, and also a serial number. The prints of photographs taken for the purpose of map-making should not be trimmed.

25. In conclusion, it will be seen from the above brief notes on photographic flying that successful mosaic photographs can only be obtained by accurate and steady flying on the part of the pilot, combined with close co-operation with the remainder of the crew of the aircraft. In flying for survey the same conditions apply, but, in order to conform with the requirements of the ground staff the standard of accuracy must, of necessity, be considerably higher, and can only be obtained by the use of a suitable aircraft and special instruments.

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CHAPTER V.

AIR PHOTOGRAPHY IN CO-OPERATION WITH THE ARMY.

Responsibility for Air Photographs.

1. A large proportion of air photographs taken during the course of military operations are obtained at the request of, and for the use of, military commanders and formations. In such circumstances the air force is concerned only with the production of the negatives and the initial issue of prints. The responsibility for the interpretation and distribution of such photographs rests entirely with the army.

2. In order to ensure that the closest liaison is maintained between air force units and the army formations with which they are co-operating, certain army officers, known as Intelligence Liaison Officers, are attached to squadrons. These officers are responsible for plotting all photographs taken for military intelligence purposes, for deciding which negatives shall be printed, and for estimating the number of prints required from each negative.

3. The type of unit most concerned with the production of air photographs for the army is the army co-operation squadron and full details regarding the procedure to be carried out in such squadrons are contained in the R.A.F. Flying Training Manual, Part V. In addition to a I.L.O., an artillery officer, known as the Squadron Artillery Officer, is attached to each army co-operation squadron to deal with all intelligence matters which relate primarily to the artillery. All air photographs required by the artillery are demanded through the S.A.O., who is responsible for the interpretation, plotting, and distribution of prints in the same way as the I.L.O. is responsible for air photographs taken for other branches of the army.

4. The duties of the I L.O. with regard to air photographs are laid down in R.A.F. Flying Training Manual, Part V.

5. When squadrons, other than army co-operation squadrons, are required to obtain air photographs for military intelligence purposes, as in the case of a day bombing squadron allotted for long distance reconnaissance duties, the interpretation, plotting, and distribution of prints is carried out at the headquarters of the formation to which the squadron belongs, unless an Intelligence Liaison Officer is attached to the squadron.

Channels of Demand and Supply.

6. The channels through which demands from the army for air photographs should pass are laid down in the R.A.F. Flying Training Manual, Part V, and are, briefly, as follows:—

"The A.O.C. will advise the military commander in the field the distances up to which the different types of squadron will be responsible for photographic reconnaissance.

"When a squadron has been allotted to a division for any operation and the squadron is receiving its orders from the divisional commander, demands for air photographs required by him will be made direct to the squadron commander concerned, through his Intelligence Liaison Officer. In this case the squadron commander must, when possible, notify the wing commander what photographic work is in hand, so that there may be no duplication of effort.

"When photographs outside this area are required, or when squadrons are retained under corps control, demands will be made through corps headquarters on the army co-operation wing, which will co-ordinate the work and allot tasks to squadrons. Demands for photographs required outside the area for which the army co-operation wing is responsible, will be forwarded to the next higher formation concerned."

7. All demands for air photographs will be dealt with at squadrons by the Intelligence Liaison Officer, who will supply the required number of prints direct to those concerned.

8. Distribution of prints will be carried out under local arrangements, and the method will vary with circumstances and with the facilities available.

Method of Demanding Air Photographs.

9. The necessary information which must always accompany a demand for air photographs is as follows:—

(i) Particulars regarding the place, or areas, of which photographs are required. Map references must be given whenever possible.

(ii) Whether vertical or oblique photographs are required.

(iii) A brief description of the purpose for which the photographs are required, or, if this cannot for any reason be given, the approximate scale of prints desired.

(iv) Order of priority of the demand in relation to other demands submitted previously, or at the same time.

(v) Distribution list showing the number of prints required, and to whom they are to be sent.

10. The height from which the photographs are to be taken is entirely a matter for the squadron commander to decide, and should not be specified in the demand. A print of approximately any desired scale can be produced by fitting lenses of different focal lengths to the camera used, and by enlarging or reducing the image on the negative obtained. The height at which it is possible to take air photographs is governed largely by the existing weather conditions, and to a certain extent by the degree of enemy interference likely to be encountered during the flight. It is, therefore, essential that the manner in which air photographs are obtained should be left to the squadron concerned. It will, however, be of great assistance to the squadron commander in deciding the type of lens which must be used in any given circumstances if he is informed of the purpose for which the photographs are required. He will then know whether large detail over a small area, or the reverse, is the object to be attained, and can make his arrangements accordingly.

11. On occasions when, for reasons of secrecy, it is not considered advisable to state the purpose for which the photographs are required, the approximate scale to which the prints should be made must be given. As the production of prints to an exact scale cannot be carried out with any degree of rapidity, and as there is rarely any necessity for this to be done, photographs can conveniently be divided into three classes as follows :—

" Large Scale "	1/3,000 to 1/5,000.
" Medium Scale "	1/7,000 to 1/9,000.
" Small Scale "	1/10,000 to 1/20,000.

These classifications should be sufficient for all normal purposes, and should always be used unless some very special reason exists for requiring prints to an exact scale.

12. In order to ensure uniformity, and to avoid the possibility of the omission of necessary information, it is advisable that a standard form of demand should be employed. Although circumstances may necessitate minor alterations in the actual form, the specimen demand shown on page overleaf fulfils all requirements and should be taken as a guide.

DEMAND FOR AIR PHOTOGRAPHS.

From :—*III Corps.*

Priority No.
2.

Serial No. : *27.*
Date : *5–7–26.*

Map Sheet.	Description and Map Reference.	Vertical " V " or Oblique "P."	Purpose for which required, or Scale.	Total No. of Prints.	Distribution.		Remarks.
					No. of copies	To be sent to :—	
XXI	*Pin Points.*				*5*	*Hqrs. III Corps.*	
	K. 27, 42.	*V*	*To confirm the existence of camouflaged battery positions.*	*30 of each.*	*3*	,, *2nd Divn.*	
	K. 31, 37.	,,			*3*	,, *7th Divn.*	
	K. 59, 64.	,,			*2*	,, *5th Inf. Bde.*	
	K. 81, 25.	,,			*9*	,, *2nd F.A. Bde.*	
					8	,, *4th F.A. Bde.*	
	J. 01, 30.	,,	*Large Scale.*				
	J. 97, 55.	,,			*30*		

J. Humphry, Maj.,
Signature of Demanding Authority.

To :—*Hqrs. 2nd (Army Co-op) Wing, R.A.F.*

13. Each definite photographic task, irrespective of the number of actual photographs involved, must be entered on a separate demand sheet. These sheets will be numbered in order of priority by the demanding authority daily. Demands which, for any reason, have not been fulfilled on the day of issue must, if still required, be repeated on successive days, and must be numbered in order of priority in relation to any new demands which may also be submitted.

14. When demands are received at the headquarters of the R.A.F. formation which includes two or more squadrons, the staff, after allotting tasks, will pass on the demand sheets to the squadrons concerned and will mark those allotted to each individual squadron in the required order of priority.

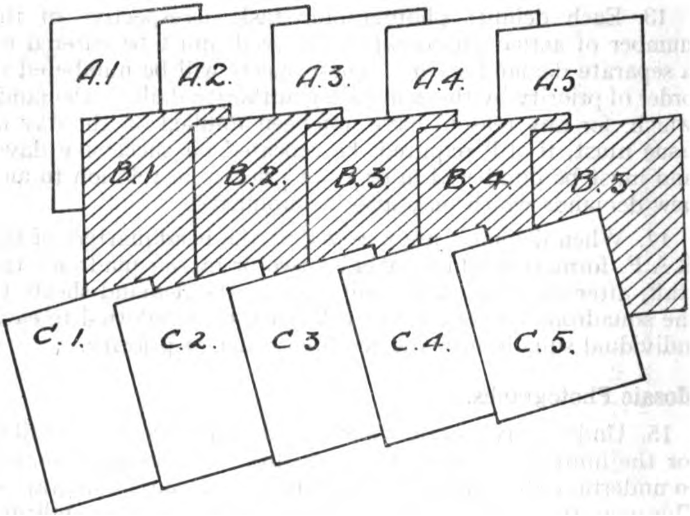
Mosaic Photographs.

15. Under active service conditions it will seldom be possible for the limited personnel of a squadron photographic section to undertake the construction of finished mosaic photographs. This operation is one which requires a considerable expenditure of time and labour, and the delay involved would, in many cases, render it impossible to supply the mosaic early enough for it to be of any value. In addition, the withdrawal of photographic personnel from routine duties would have an adverse effect on the speed of production of ordinary prints.

16. On the majority of occasions when a photographic reproduction of a large tract of country is required, a set of overlapping prints which cover the area concerned and which can be put together by the recipient will be sufficient to fulfil all requirements. In order to facilitate the piecing together of loose prints by persons unused to the appearance of air photographs, a system will be employed whereby the position of each print in relation to the others is indicated by a letter and a number. These will be marked in pencil on the back of each print as follows :—

17. Each row is given an index letter. The first row is given the letter " A," and each print in that row will be numbered consecutively thus :—" A.1," " A.2," " A.3," etc. The second row is given the letter " B," and the prints in that row also numbered consecutively starting with the number " 1." Successive rows are marked in a similar manner. An example of this method of marking is shown in the diagram given below.

18. An additional advantage of this method is the fact that the whole of each print is available for examination, and that the possibility of the loss of important detail at the edges owing to the cutting or to the incorrect superimposition of overlapping portions is consequently avoided.



Type I Mosaic.

A set of loose, overlapping prints of this nature is termed a "Type I Mosaic." A finished production in which the prints are cut, fitted together, and mounted on a permanent base, is known as a "Type II Mosaic." These classifications should always be employed when submitting demands for mosaic photographs.

Chapter VI.
of
AIR PUBLICATION 1354.
(*Published March,* 1929.)

CHAPTER VI.

AIR PHOTOGRAPHY IN CO-OPERATION WITH THE ROYAL NAVY.

General.

1. Although air photography affords a valuable means of obtaining naval intelligence under certain circumstances, it is not of such paramount importance to the Royal Navy as a whole as it is to the Army. Aircraft operating with the fleet in the open sea can obtain little useful information by means of the air camera, although it is sometimes of value for confirming observers' reports of occurrences such as the presence of enemy submarines or surface craft in certain localities at certain times. On the other hand the employment of cameras on air reconnaissances of enemy harbours and coast lines is essential, the type of information required in these circumstances being similar in many respects to that obtained by reconnaissance over land for military purposes. Further, when combined operations are being undertaken by two or more of the services together, the carrier-borne aircraft operating with the fleet will normally be responsible for all air reconnaissances of enemy territory until such time as a suitable land base has been secured from which the army co-operation squadrons can operate. During this period air photographs will be required by both the naval and military commanders, and the personnel of the Fleet Air Arm must therefore be capable of undertaking this work in addition to their other duties.

2. In time of peace, air photography is used extensively by the Navy in connection with gunnery and torpedo training, photographs of the fall of shot round a target, and of the tracks of torpedoes, being of considerable value to those responsible for directing such operations.

Responsibility for Air Photographs.

3. Just as is the case in army co-operation, R.A.F. personnel and units working with the Navy are only responsible for the production of air photographs, the work of interpretation being the duty of the naval staff. Instructions as to what photographs are to be taken are issued by the commander-in-chief of the fleet, and the detailing of any particular carrier or capital ship to despatch aircraft to carry out the work is also

undertaken by him. The actual taking of the photographs is the duty of the flying personnel, and the production of prints is done by the R.A.F. photographic section in the aircraft carrier, the finished results being despatched to the commander-in-chief's staff for further action.

4. In view of the close co-operation which naturally results from the fact that naval aircraft and their crews are carried in ships of the fleet, no system of liaison officers, similar to the Branch Intelligence Officers attached to army co-operation squadrons, is necessary. When, however, carrier-borne aircraft are required to co-operate with land forces in the course of combined operations, and to obtain air photographs on behalf of the military staff, it will usually be advisable for an army I.L.O. to be attached to the ships concerned for the purpose of co-ordinating the work, and of extracting the desired information from the results obtained.

Organisation.

5. As the Fleet Air Arm is an integral part of the Royal Navy, the responsibility of the R.A.F. as regards the organisation of photographic work goes no further than the individual photographic section. Each aircraft carrier is equipped with a photographic section, the work of which is carried out by R.A.F. personnel under the control of a suitable officer.

6. The work of these sections is practically identical with that carried out by normal squadron sections, and the organisation is therefore the same in principle. The provisions of Chapter III may therefore be taken as applying equally to both, subject of course to such modifications in procedure as are necessitated by the difference in the conditions prevailing in a ship to those experienced at a land aerodrome.

7. The organisation of air photography in shore-based units of the R.A.F. which, although required to undertake duties in co-operation with the Navy, are under the direct control of the R.A.F., is in accordance with the principles laid down in Chapters II and III.

Chapter VII.
of
AIR PUBLICATION 1354.
(*Published March,* 1929.)

CHAPTER VII.

INTERPRETATION OF AIR PHOTOGRAPHS.

General on Types of Photographs.

1. *Difference of type.*—Photographs taken in the usual way from a ground station are used to illustrate the view from O.P.'s or to accompany reconnaissances or reports. The view they give is that usual to the eye, and objects in the foreground are naturally larger than those in the distance. A photograph taken from an aeroplane with the same horizontal axis would show little but sky. Air photographs are taken therefore with the camera depressed below the horizon (obliques) or pointing straight downwards (verticals). Neither appear quite natural to the eye. A mental picture of the difference will be obtained by thinking of a few chessmen on a chessboard. Putting the eye at the level of the board, the chessmen are seen in elevation (ordinary ground photograph). Looking sideways and from above, at an angle of about 45° the chessmen are foreshortened, and the square of the chessboard are seen in perspective (obliques). Looking directly down on to the centre of the board the squares look correct and are no longer in perspective, but the chessmen are seen in plan only—(vertical).

2. *Value in examining ground.*—(i) The value of obliques and verticals in the examination of ground is seen clearly from the analogy of the chessboard. The oblique shows more of the ground than can be seen from any ground station, and it shows hill features and objects in a way more or less familiar to the eye, although not so well as from a ground station. The vertical shows the ground in plan, and no detail, except under trees or artificial cover, escapes notice. The oblique is useful in showing the natural difficulties of nature—hills, ravines, defiles, and the best covered line across country. The vertical shows more clearly still local difficulties, such as water, marsh and plough, and the details of towns, villages, railways, roads, tracks, canals, earthworks, etc., but gives practically no clue to hills, valleys and contours generally.

(ii) Photographing from a ground station it is possible to take a series of overlapping views, which, joined together, form a complete panorama. The same would be possible for "obliques" from an aeroplane if a sufficient number of cameras could be used simultaneously and at the same angle to the horizon—with a single camera it is not possible because the aeroplane travels too fast (and therefore too far) between exposures. Verticals, however, being nearly (though not quite) correct in plan can be joined up to make a combined picture or mosaic of a large area. Mosaics provide a useful guide to country, but, like single verticals, do not show heights.

3. *The Stereoscope—general.*—In the preceding paragraphs photographs were considered singly (even in mosaics there is only one single picture of any one small area). In this single form they represent what one eye would see from the position of the camera. Normally, however, we use not one but both eyes, and we are able to measure distance, and to appreciate shape and form because of the distance between the pupils (about 2½ in.), which is the " base " of the human range-finder. The base being small, normal vision has " stereoscopic " or range-finding power which extends for not more than 300 yards. Beyond that limit distances are judged by relative size and clearness. The same stereoscopic effect (but extending to much greater distances) is to be got from two photographs of the same object taken from different points of view* and seen through a stereoscope. The photographs must, however, be taken at about the same distance from, and at about the same angle to, the horizon. The use of a stereoscope alters the respective values of the oblique and the vertical. Supposing that two verticals are taken at about a distance of 1 mile from each other in the air, then the " overlap " between them (about half of each photograph) will show the same country from two points of view. Looked at in the stereoscope this overlap is seen in the form of a raised model on which tactical features and ordinary detail are brought out equally clearly, and in which the respective advantages of oblique and vertical are combined.

4. *Types of Photographs* —Photographs may then be considered under the following headings :—

- (i) Ground photographs (including panoramas) : These require no further explanation.
- (ii) Obliques : Always used singly.
- (iii) Verticals :—
  - (*a*) Single
  - (*b*) Made up in mosaic form.
  - (*c*) Used in pairs with the stereoscope.

Note —With (i) and (ii) it may be possible to use the stereoscope, but so rarely as to make it unnecessary to go further into the question. On the other hand, with (*c*) a stereoscope is easy to use and adds largely to military value.

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* No stereoscopic effect is possible without different points of view. For example two copies of a map or two identical photographs can give no stereoscopic effect.

5. *Use of maps.*—Any photograph, of whatever type, deals with a small portion of the ground, and is undefined in scale and orientation. Like the thumbnail sketches which accompany a report, photographs must be studied with the map. The map is the authority for distances, bearings and the general tactical features of the ground. The photograph adds local information both of topography and of the dispositions of the enemy. Maps and photographs are, therefore, complementary and must be used together.

6. *Obliques.*—Obliques represent a sector bounded by lines which start at the camera and open out (at an angle which may vary from 40 to 60 degrees) to the horizon. Each oblique therefore illustrates the view from a single point, and is not correct for any other point of view. It is useful, as a general guide, for any point within its sector, but must not be taken as correct in direction or relative distance except from the point above which the camera was exposed. That point will never be known accurately, however, and it becomes more than ever essential to use the map at the same time. Obliques are most useful in orienting the line of attack. Since the view of an ordinary oblique is very similar to that which might be seen from the top of a mountain, no special instruction in its use is necessary. If, however, the oblique is depressed much below the horizon objects will tend to appear more in plan than in elevation and the remarks of the succeeding paragraphs on verticals will be found useful.

7. *Verticals.*—Verticals, as being at once easiest to take from a military point of view, and most useful for all topographical and military purposes, form the bulk of photography on service. They show the ground from an unfamiliar point of view and require special explanation, but it must not be forgotten that common sense is the chief requisite for their study. If it is remembered that everything is in plan and if one or two verticals are compared on the ground with the country represented, little difficulty will be found thereafter. Verticals are used for the following main purposes—

(i) *Examination of tactical features.*—In some cases photographs are used as a substitute for large-scale maps for particular operations. In others they are studied for the particular needs of different arms, as, for example, the topographical obstacles to tank movement.

(ii) *Intelligence.*—Commonly dealt with under the heading "interpretation," this point will not be enlarged upon. It is a matter of common sense, training, and knowledge of contemporary tactical method.

(iii) *Mapping.*—Of interest to army technical troops only, except in so far as it is dealt with for sketching purposes in Chapter XVI of the Manual of Map Reading.

8. *Data required for use of verticals.*—Before using a vertical photograph, certain facts regarding it must be known. These facts are much the same as in the case of a map, but include one important addition in the direction of the light and consequently of the shadow cast by tree, house or any other vertical object. Thus, as with a map, it is necessary to know—

(i) the position or area illustrated.
(ii) the scale.
(iii) the orientation.
(iv) the serial number (for reports, or for further demands).

and in addition—

(v) the direction of light.
(vi) what objects look like when photographed from above.

To provide as much as possible of this information, the following data are given in the margin of a photograph taken with F.8 camera.

(*a*) Time of exposure.
(*b*) Height of exposure (above level of aerodrome).
(*c*) Date.
(*d*) Focal length of lens.
(*e*) Unit taking photograph.
(*f*) Levels.
(*g*) Serial number of photographs.

As explained below—

(i) is found by comparison with the map.
(ii) can be deduced from (*b*) and (*d*) and must be verified from the map.
(iii) can be deduced roughly from (*a*) if the direction of light and shadow (v) can be seen clearly on the photograph.
(iv) is the unit (*e*) and the serial number (*g*).
(v) can be deduced from (*a*) if the orientation has been found from the map, or it can be found by inspection of the shadows on the photograph itself.
(vi) is a matter of common sense and of the principles given below.

If old patterns of camera (not equipped with the " data " panel of the F.8.) are used, information is generally inscribed by hand on the negative. In all cases the necessary information can be got by comparing photograph and map. Where time permits, the grid position of each photograph is given on its reverse side by the Intelligence Liaison Officer.

9. *Identification.*—Identification of the area covered is perhaps the greatest difficulty. The photograph is generally on a much larger scale than the map, which may be out of date, or so much generalised as to afford little clue to the position of individual prints. If a series of photographs is available, proceed as follows.—Examine on the map the area over which the aeroplane was photographing. Pick out one or other of the following—

(i) Railways.

(ii) Roads with characteristic bends, corners or junctions with other roads. A long and more or less straight stretch should be chosen.

(iii) Rivers and canals of well-marked shape or junction and sufficiently straight and long.

Identify a photograph of some portion of the chosen object and then proceed to follow along the same feature until three or four photographs have been correctly placed and the scale has been roughly gauged. Now look on the map for towns, villages, lakes and woods in reference to the railway, river, or road originally chosen and place other photographs roughly in position until all have been located. With a single print it will be found best to choose some large and well-defined object in the photograph and to look for it on the map.

10. *Scale.*—(i) Only in perfectly flat country will the scale be constant over the whole area. In mountainous country the scale will vary and can only be ascertained approximately. The top of a mountain is nearer to the camera than its base and appears therefore at a larger scale. In undulating country the variations in scale will not be noticeable for practical purposes, but supposing that the general level of the country is higher on one edge of a photograph than the other, the effect may be very marked. For example, if a straight line of railway appears on the left edge of a strip of several photographs and the country rises from it to a line of hills on the right edge, the photographs if fitted together, will tend to form a circle and the railway, actually straight, will bend at each join. In no case, then, can the deduced scale be anything more than the view scale over the area in question.

(ii) The only method of obtaining a true scale is to compare the distance on the photograph between two objects with the distance on the map (or ground) between the same two objects. As a simple example, the distance measured on a photograph · between a certain road junction and a railway bridge is 3 inches and from the map it is found that the distance between the same point is 1 mile. There the scale of the photograph is 3 inches to a mile.

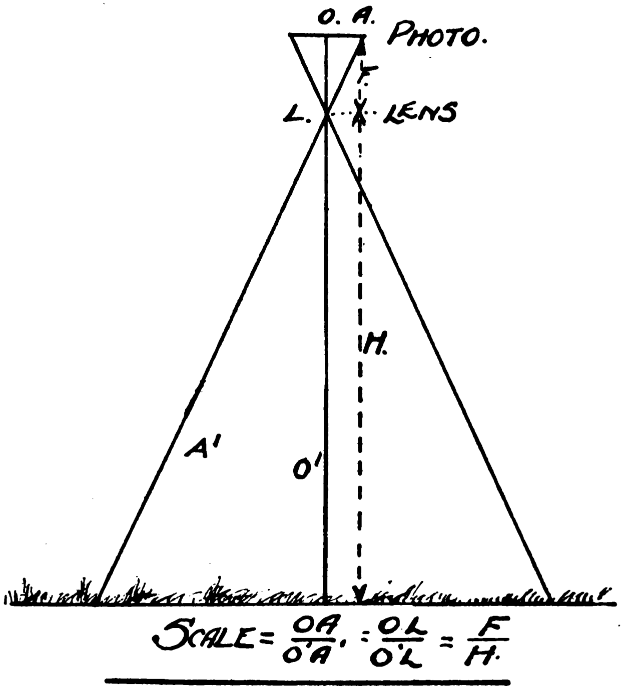
(iii) The scale may be obtained approximately by measuring on the photograph the size of objects such as width of road or railway, houses, etc., the actual size of which is known, or

(iv) by obtaining the R.F. from the formula

$$\frac{\text{focal length of lens (F).}}{\text{height (H).}}$$

Both factors are given in the " data " panel on the photograph (see para. 8) but both must be in the same unit-example—F. (focal length) 10 inches, H. (height) 12,000 feet. Then scale is $\frac{10}{12}/12,000$ or $\frac{1}{14400}$ (about 4 inches to the mile).

The scale thus obtained is that of any ground at the level of the aerodrome.



CHAPTER VII, FIG. 1.

This R.F. will be the scale of the photographic negative (or contact print) and therefore it must be known whether the photograph being dealt with is a contact print or an enlargement. If an enlargement, the R.F. must be adjusted accordingly.

11. *Orientation.*—Where photographs have been "placed" on the map the orientation follows as a matter of course. Where they have not been placed, shadows must be studied in conjunction with the time of exposure (para. 8). It is often difficult at first to identify the direction of shadow. For example, an avenue of poplar trees will cast shadows which are often taken to be the trees themselves (the latter appearing as small dots at the ends of the shadows, easily identified in the stereoscope but difficult to pick up on individual prints). Nevertheless, trees and houses are the safest guide to direction of shadow. If they do not exist on the photograph look for bridges, or telegraph or other poles. It is but a rough orientation which can be obtained in this way, and a rough idea of where the sun was at the time of exposure will suffice. Cuttings and embankments are dangerous as a guide to shadow because, as will be explained later, they may be confused with each other if the photograph is not placed in its correct position relatively to the window or source of artificial light.

12. *Direction of light.*—At the time of exposure the sun casts shadows in a direction due to its position at that moment. In studying the photograph afterwards the light from window, or artificial source, must be made to fall on the photograph in the same direction as did the sun's rays on the ground. If shadows appear to point towards, instead of directly away from, the light the effect is so contrary to nature that embankments look like cuttings and mounds like holes. This rule then, "reproduce the lighting conditions of nature" applies to any vertical photograph, single mosaic, or stereoscopic pair, and misleading or inferior results will inevitably occur if it is not followed.

13. *Objects of characteristic shape.*—Even though colours are not represented, except in tone, on the photograph, certain features are unmistakable. The straight lines and even curves of railways, the buildings of a town, the roads (generally whitish in tone) the water (generally black or dark grey) and woods are at once recognisable.

14. *Colour and light.*—To understand the general appearance of country, two factors affecting the photographic tone or depth must be appreciated. These are :—

(i) Photographic tone value of colour.
(ii) Reflection of light.

Thus, a road will look different in tone according as the surface varies in colour (tar, macadam, etc.), and according as that surface reflects light to the camera.

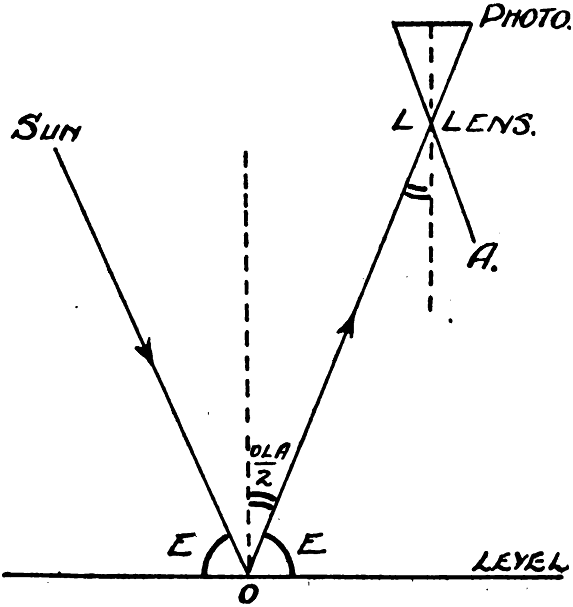
15. No colours are given on the photograph, but each colour has its corresponding tone (or darkness) somewhere intermediate between black and white. Thus, a patch of poppies in corn would appear black against a mottled lightish background,

and pasture is substantially darker in tone than stubble. The effect of photographic tone is, however, modified and often negatived by the greater effect of reflection.

16. (i) The more light reflected by an object the whiter does it appear on the photograph. The amount of light reflected depends on the nature and texture of the surface and upon the angle which that surface makes with the sun's rays and the photographic plate.

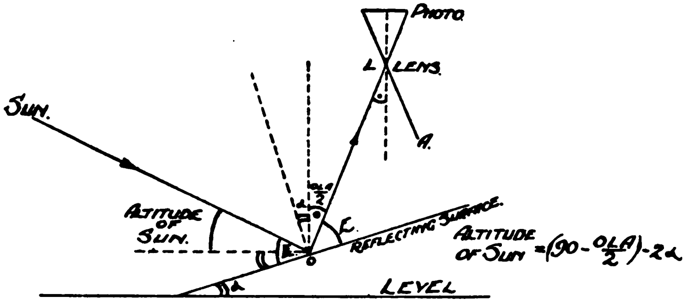
(ii) Light striking a perfectly smooth surface at an angle of E (angle of incidence) is all reflected at the same angle (fig. 2); if the camera lies in the path of the reflected light, the object will appear white on the photograph; if it does not, the appearance of the image of the object will depend on its colour. The amount of light reflected according to this rule depends on the degree of smoothness of the object.

(iii) Smooth water, which reflects most of the direct light falling on it, may be taken as a simple example. In fig. 2 the angle O L A represents the range of a camera taking a vertical photograph. Light will only be reflected on to the photograph when E is equal to or greater than $90° - \frac{O\,L\,A.}{2}$ $\frac{O\,L\,A}{2}$ depends on the camera in use, but will not be more than 30°. Therefore, the sun will only be reflected on to the photograph from smooth water, when at an altitude of 60° or more, and it will then appear as a white patch merging off gradually into black, the usual photographic tone of water.



CHAPTER VII, FIG. 2.

(iv) But all reflecting surfaces are not level, and, no matter what the altitude of the sun may be, there may be some that will reflect light on to the photograph, e.g., glass roofs, roads on hills, etc. In such cases the same rule of reflection applies, as shown in fig. 3.



CHAPTER VII, FIG. 3.

(v) This argument can now be applied to irregular and rough-surfaced objects whose surfaces can be considered as consisting of a number of reflecting surfaces of various sizes inclined at different angles to the level. The nature of the object will determine the quantity and size of such surfaces and the possibility of any of them reflecting light direct to the camera.

(vi) Objects that partly reflect light to the camera will appear lighter on the photograph than the image of their natural colour. Examples will be found in para. 17.

(vii) The preceding sub-paragraphs will explain why tracks are so easily picked up on air photographs. The earth, grass or vegetation is crushed flat so as to alter the reflection of light, whilst in many cases the straightness and evenness of the track or path gives an additional clue.

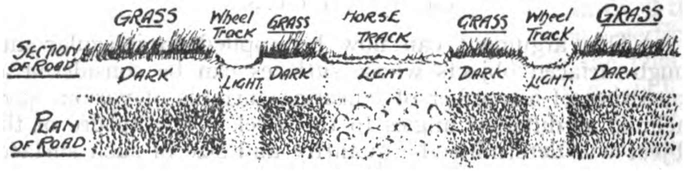
17. *Examples of the appearance of topographical features on vertical photographs.*—(i) *Roads, tracks and paths.* (*a*) Roads are, in general, of uniform width and run in straight stretches of varying length with regular bends. Sharp bends will usually only be found in broken country where embankments, cuttings and bridges are also more frequent. Tracks and footpaths tend to be more uneven in width and twist more than roads. In low-lying, damp country this is particularly evident as tracks and paths deviate round minor obstacles which would be cleared away for a road.

(*b*) Tarred roads, owing to their colour, should appear black, but as they reflect indirect light appear dark grey. Where the sun is reflected directly to the camera the road appears white, shading off to grey again on each side of the reflecting point. Usually there is a narrow light strip down each side of the road, caused by the accumulation of dust on the least-used parts and by the greater reflecting power of the sides of the camber.

(*c*) Macadamised roads, owing to their colour, appear light grey approaching white. The surface, though rough, is flat, and therefore reflects indirect light, to some extent adding to the light appearance. The rough surface does not reflect the direct rays of the sun so much as a tarred road, and it never appears such a dazzling white.

(*d*) The width of roads cannot be measured with certainty, as the edges, which are least used, merge into and are lost in grass margins.

(*e*) Unmade roads, tracks and paths appear in the same tone as macadamised roads. When little used they are slightly darker, as the rougher surface is a poorer reflector. Wheel tracks appear as two light lines. A central line of slightly lighter tone (see fig. 4) implies horsed traffic.



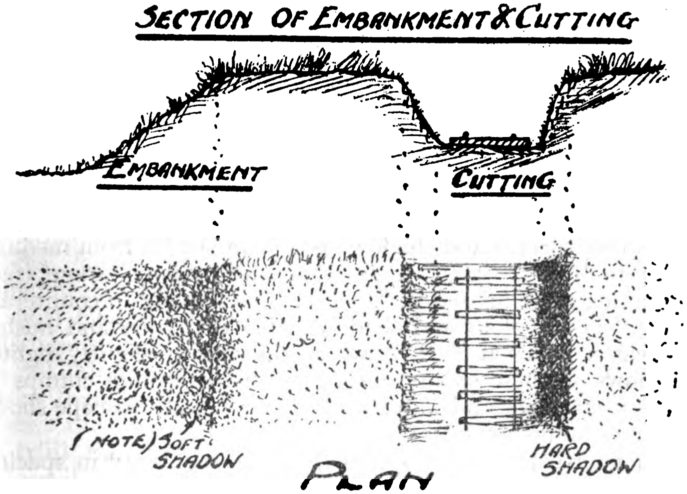
CHAPTER VII, FIG. 4.

(ii) *Railways,*—Distinguished by dead-straight lengths and regular curves (more regular than on roads). Width is uniform and, in highly developed countries, embankments and cuttings are frequent. In hilly country curves are more frequent and tunnels occur. In general the tone is a medium grey due to the broken surface and shadows of the ballast. On clear photographs and those taken at a low altitude (5,000 ft.), the shadows cast by the rails are often seen.

(iii) *Telegraph poles.*—These almost invariably occur along a railway and frequently along roads in developed countries, but cannot be directly identified on a photograph except by their shadows. Strong sunlight and a suitable background are necessary to show them up. Telegraph lines may be identified by the shadows of the poles or by small spots indicating ground round each pole that has not been touched by cultivation. These shadows or spots will be at regular intervals and probably ranged in a series of straight lines.

(iv) *Bridges.*—These will be looked for at the crossings of roads, tracks, railways and water or at sharp dips in the ground. They are not always straight but generally uniform in width and probably cast a shadow. Most bridges have parapets, and the tops of these often appear as light grey or white lines as they are usually smooth. Outward projection of these parapets indicate the probable existence of piers.

(v) *Embankments and cuttings* are regular in shape, and can be identified by their shadows (fig. 5).



CHAPTER VII, FIG. 5.

If the slopes away from the light are in shadow they appear, of course, dark ; if not in shadow the angle of incidence of the light is so small that there is little chance of reflection towards the camera, and therefore they appear darker than the immediately surrounding ground, unless of such material as chalk. The slopes facing the sun, on the contrary, appear light grey or white, as the angle of incidence of the light is more favourable.

(vi) *Hills and depressions* (*quarries*).—The same considerations apply to rugged features as to embankments and cuttings, with the exception that they are usually of irregular shape. But in undulating country, slopes have no distinctive appearance, and the considerations discussed in para. 16 must be applied.

(vii) *Water*.—(*a*) Smooth water, except where it reflects the direct sun's rays into the camera (see para. 16) appears dark grey or black as it reflects only the indirect light from the sky. If the water is shallow, with a light bottom or weeds, the latter will reflect some light and the water appears lighter in colour. Thus, some idea of the depth of the water may be obtained. It is not easy to be sure whether mud or sand is covered by shallow water or exposed by low tide.

(*b*) Rough water, either sea or stream, presents innumerable reflecting faces to the light. Some light is then reflected into the camera with the result that white patches appear on the photograph. If water is ruffled by a light breeze these patches tend to appear in lines, whereas on a tumbling river or in surf the patches are irregular and cover a greater area.

(*c*) Streams and rivers never show straight lines unless embanked, and generally follow a tortuous, irregular path. There is little chance of confusing streams with any other feature.

(*d*) Canals are smooth-surfaced except when touched by a breeze, and appear dark grey or black. They are uniform in width and follow the contours. Frequently a tow path appears as a light line along one side. Locks may be identified by bars of light and shadow across the water.

(viii) *Trees, bushes, scrub and hedges.*—(*a*) These, with both reflecting surface and shadow, appear in shades from medium grey to black. Thus, a wood appears patchy—some trees reflecting more light than others and so tending to counteract the effect of colour and shadow. Isolated trees and bushes appear as circular dark spots at the end of slightly lighter shadows. These shadows assist in distinguishing clumps of trees from ponds and water generally. The stereoscope shows up trees unmistakably.

(*b*) Orchards are distinguished by the regularity in spacing of the trees.

(*c*) Scrub, usually mixed with grass or sand, appears as darker patches on a lighter tone. If the scrub is thick, shadows will be visible.

(*d*) Hedges appear as dark, irregular lines with or without shadow according to their height.

(ix) *Grass, heath and swamps (marsh).*—(*a*) Viewed from above, grass presents a broken surface reflecting little light. Its appearance, therefore, depends on colour and on its length and consequent shadow. Short grass appears lighter as it presents a better reflecting surface and may show the soil underneath. In general, grass is between light and medium grey and patches of coarse grass or heath are darker with a mottled appearance.

(*b*) Heath, merging into bog or marsh comprising irregular patches of water, is in darker shades of grey with the same mottled appearance.

(x) *Crops and general cultivation.*—(*a*) With all crops the same arguments apply as with grass ; young crops appear a medium grey, ripening crops light grey. Such things as roots, beans, etc., presenting large leaves and corresponding shadows have a mottled appearance in medium or dark grey.

(*b*) Freshly ploughed land (and likewise fresh earth from excavations) presents a large proportion of flat surfaces to the light and therefore appears light. After harrowing, where surfaces are broken up, a darker shade is assumed. The nature of the soil decides the exact shade in each case ; chalky soil always appears white, clay appears almost white when ploughed and darker soil a light grey.

(*c*) Heavily cultivated country appears as a mosaic or patchwork of varying shades and, except on large-scale photographs, it is difficult and frequently impossible to distinguish the nature of each patch of cultivation.

(xi) *Soil, sand and rocks.*—(*a*) In general, bare ground appears light, as do unmade roads. Chalky soil is indicated by white patches ; clay is generally darker.

(*b*) Sand, providing a comparatively smooth surface, appears light ; deeper-toned patches indicate slopes.

(*c*) Rocks vary from white to dark grey according to whether their surface is smooth or rough and broken. Wet rocks, facing the sun, reflect the light and appear white. Shadows are deep and well defined.

(xii) *Fences, ditches and walls.*—These are difficult to distinguish on photographs taken at usual heights, as the scale is not large enough to show them up. They may be found from their shadows when the sun is low. The stereoscope shows them up at once and differentiates one from the other.

(xiii) *Buildings.*—Owing to their flat surfaces, buildings generally produce high lights or at any rate light patches. Shadows are clear and well defined. Cottages are easily picked out after a little practice, but may be confused with haystacks.

The foregoing examples are hints, and only hints, on the photographic appearance of natural objects. There are two factors governing the appearance of objects which must always be borne in mind—time of day and season. The former gives the elevation of the sun and therefore the degree of reflection and extent of shadow to be expected. The latter controls the natural appearance (and, therefore, the photographic) of some objects, e.g., in parts of the world rivers only hold water at certain seasons and therefore will appear black, when with water, or light grey to white, depending on nature of bed, when dry.

18. Where the nature, or even existence, of a particular feature is in doubt, other and overlapping photographs of the same area will help, not only stereoscopically, but because of the different point of view. Paths or streams in forest country are most visible, for example, where they run to or from the centre of the photograph. They may be clearly distinguishable in this case although hard to find on another photograph.

19. *Limitation by scale.*—Many objects will be too small to appear on a photograph of comparatively small scale, and a sense of proportion must, therefore, be exercised. On a scale of 3 in. to 1 mile—an average scale—1 ft. is represented by about 1/2,000 of an inch.

20. *Indications of height.*—As before stated, single verticals afford no direct evidence of height. They do afford many clues to it, however. Thus, roads and railways are graded.

If a road or railway lies in a cutting it is crossing a spur or running up and down a convex slope. If on an embankment it will be running across a stream line or up and down a concave slope. On a sharp hillside lynchette (or steep banks) show the top or bottom of fields and follow the general line of a contour. Sheep or cattle-tracks take an easily graded line up and down hills. In vine country, Central and Southern Europe, Palestine, etc., walls between fields follow the contour more or less, whilst in tropical Asia paddy fields (always arranged for irrigation) also follow the contour. Lines of plough are not a reliable guide because they allow of drainage in one or other direction. Shadow may show up sharp slopes, and may give some grasp of tactical feature, but is of more value in estimating the size of banks, cuttings or hedges. To estimate heights in this way it is necessary to have a rough idea of the heights of the cottages and trees in that particular neighbourhood or of the width of road or permanent way upon which the shadow is cast. The most certain clue, however, is that afforded by the drainage, or rivers or streams, by which water is carried away.

21. *Mosaics.*—Mosaics will rarely be available on service. They are particularly useful either for the attack or defence of towns, villages or strong points. Mosaics are particularly difficult to make, and unreliable when made, in hilly country, but even in flat country they should not be relied upon for distance or bearing. It is advisable to draw the map grid on the mosaic by inspection.

22. *Stereoscopic pairs.*—Since an overlap of 60 per cent. between successive prints is always allowed for, it is possible to examine the whole of the ground stereoscopically, and it is only in this way that the full value of the photographs can be obtained. Generally speaking, the effect of height is emphasised so as to make the vertical scale two or three times the horizontal (the further apart the two points of exposure are in the air the more is the height scale exaggerated). Before estimating heights, then, a rough figure for the heights of hills for the bottoms of valleys should be obtained from the map. Intermediate heights can then be estimated and the size and importance of obstacles gauged. The ordinary rules of lighting, of colour tone and of reflection, apply in stereoscopic as in single print examination, but it is far easier to identify the actual feature of the ground or the purpose of any artificial work, stereoscopically than otherwise.

23. *Negative marks.*—These occur sometimes and must not be confused with details of the ground. They are usually scratches or marks of dried drops of liquid on the negative. If any doubt exists as to whether an object exists on the ground or is a mark on the negative, compare the photograph with another which includes that portion of the country.

Chapter VIII.
of
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CHAPTER VIII.

TRAINING OF PHOTOGRAPHIC PERSONNEL.

General.

1. All photographic training is carried out at the School of Photography, South Farnborough, where a number of courses are held during the year for both officers and airmen. A sound initial training is essential for all ranks employed on photographic duties. All airman photographers are, therefore, required to pass through the school, and to pass successfully the various tests laid down before being posted to service units. Officers who are required to take charge of photographic work in such units should also first pass one of the officers' courses held for the purpose of fitting them for their duties.

Unit Training of Airman Photographers.

2. In order that the training which airmen receive at the School of Photography may not be wasted through lack of practical application of the knowledge so obtained, and in order that a high standard of proficiency may be secured, it is necessary that they should be given constant practice in all branches of their work.

3. A squadron photographic section is, however, but one link in the technical organisation which enables a squadron satisfactorily to perform its various duties. It exists, primarily, for the purpose of carrying out the ground work required in connection with the air photography performed by the flying personnel. The amount and nature of the work depends very largely on the nature of the squadron's activities from time to time.

4. In view of this, it is impossible to prescribe any definite training scheme for photographers employed in unit sections. If the amount of air photography which is undertaken by the squadron is sufficient, and if it is carried out more or less continuously throughout the year, no special training exercises will be necessary for the ground personnel, as they will obtain ample practice and experience in the course of their normal duties. But if it happens that, owing to bad weather, or to pressure of other work, long periods occur during which little or no air photography is carried out, it is then the duty of the squadron commander and the photography officer concerned to devise some means of providing the airmen of the photographic section with adequate technical employment. This is best done by instituting a series of training exercises, any

of which can be carried out, not in accordance with a set programme, but at any time at the discretion of the officer responsible.

5. The following specimen exercises may be taken as a guide in drawing up such a scheme. This list is not intended to be comprehensive, and squadron photography officers may amend the details of any exercise, and should endeavour to evolve others of a similar nature, to suit their own requirements. In addition to providing useful employment and to affording adequate practice, in the various operations and processes involved, such exercises also constitute a valuable test of the general standard of proficiency both of individuals and of the section as a whole.

(i) *Loading plates in " P.7 " magazines.*—Old negatives or unserviceable exposed plates may be used. A given number of magazines to be loaded in complete darkness within a fixed period. Magazines must be examined afterwards for faults, e.g., bent sheaths, fragments of glass, etc. The time allowed should be gradually decreased, the object of the exercise being to increase speed in loading and at the same time to develop care in working.

(ii) *Loading MacKenzie Wishart Envelopes.*—Similar to (i).

(iii) *Loading plates in developing racks and tanks.*—Similar in principle to (i) and (ii). To be carried out in complete darkness.

(iv) *Development of air negatives.*—If no air negatives are available, this exercise may conveniently be carried out with plates exposed on the ground in a " P.14 " camera. A given number of plates to be unloaded, developed by the time and temperature method, fixed, washed and dried within a fixed time. Negatives to be examined carefully afterwards both for physical faults (scratches, blisters, frilling, pinholes, etc.) and for chemical faults (stains, drying marks, etc.). Time allowed to be gradually decreased.

(v) *Bromide printing and enlarging.*—Old negatives may be used. A given number of contact prints, or enlargements, to be made within a fixed period. Prints to be examined afterwards for colour, definition, and possible faults. Time allowed to be gradually decreased. Several airmen may be employed on this exercise together.

(vi) *Marking and titling negatives.*—Old negatives, or pieces of plain glass, may be used. The object of this exercise is to increase speed and neatness. It should be carried out at frequent intervals, especially by airmen who are naturally slow or untidy writers.

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CHAPTER IX.

PHOTOGRAPHIC TRAINING OF FLYING PERSONNEL.

General.

1. In each squadron which is required to carry out air photography, every pilot, observer, and air gunner should be capable of undertaking a photographic flight as a part of his normal duties. The entire responsibility for the actual taking of air photographs rests with the crew of the aircraft. Carefully designed equipment, and an efficient ground organisation are both valueless unless the flying personnel are capable of performing this first operation successfully.

2. To do this, two things are necessary. First, the pilot must be able to fly the aeroplane accurately, and secondly the camera operator must be able to operate the camera correctly and be capable of remedying simple faults in the mechanism while in the air. These are not difficult operations, but those concerned require preliminary instruction in the correct methods of carrying them out, and then careful practice in such methods, before they can be undertaken with any certainty of success. As it is neither possible nor desirable to give every officer and air gunner a course of instruction at the School of Photography, this training must, therefore, be carried out by squadrons.

3. It is the duty of area and group photography officers, after consultation with those branches of the staff responsible for other forms of training, and with the approval of the area or group commander, to draw up programmes of annual photographic training for the units under their control. Squadron commanders must allot a portion of the individual training period for the purpose of carrying out these programmes, and are responsible that the personnel under their command attain the required degree of proficiency. Care must be taken, however, not to confine the performance of air practices to any fixed periods or dates during the individual training season. Photography is dependent, more than any other form of air work, on weather conditions, and unless the training programme is made elastic so that advantage may be taken of spells of fine weather whenever they occur, it will usually be found impossible to carry out as many flights as

are necessary. This procedure is simplified by the fact that a camera can be carried on almost any flight, and air photography practices can be carried out without inconvenience in conjunction with other forms of air training.

4. Photographic training will be divided into two portions, ground lessons and demonstrations, and practical air exercises. The squadron, or station, photography officer, is responsible for giving the necessary instruction, and for watching the progress of each individual. He should keep a careful record of such progress, and must endeavour by his personal efforts to assist officers and airmen to overcome any difficulties which they may experience, and to attain the required standard of proficiency. It is not sufficient for him merely to record the result of each exercise as successful, or the reverse.

Ground Training.

5. Ground training will consist of a series of lectures and lessons, which will include practical demonstrations of the methods of operating the various cameras. The subjects covered will depend on the type of squadron, but the following syllabus is given as a general guide:—

(i) *The " P.7 " Camera.*
  (*a*) Method of operation, by hand and power.
  (*b*) Changing magazines.
  (*c*) Maintaining the camera level on its adapter and mounting.
  (*d*) Possible stoppages, and methods of remedying them.
  (*e*) Testing the camera for correct working after installation in the aeroplane.

(ii) *The " F.8 " Camera.**
  (*a*) Method of operation by hand and power.
  (*b*) Changing film magazines.
  (*c*) Maintaining the camera level, and the use of the turntable adapter.
  (*d*) Use of the remote control and timing device.
  (*e*) Testing the camera and controls for correct working after installation in the aeroplane.
  *(This subject may be omitted in squadrons which are not equipped with this type of camera.)

(iii) *The " P.14 " and " P.18 " Cameras.*
  (*a*) Method of operation.
  (*b*) Changing plates.
  (*c*) Method of holding camera.

(iv) *Calculations for Air Photography.*

- (*a*) Calculations for area covered.
- (*b*) Calculations for time-interval and overlap.
- (*c*) How to find scale when height and focal length of lens are known.
- (*d*) How to find height when the required scale and focal length of lens are known.

(v) *Photographic Flying.*

- (*a*) Photographing pin-points.
- (*b*) Methods of flying along run lines.
- (*c*) Methods of maintaining a straight course, and of obtaining a correct lateral overlap without the use of a map.
- (*d*) Flying for oblique photography.

Air Training.

6. Air training consists of the practical application of the principles learnt during the ground instruction. Definite practices should be laid down, and these should be carried out as many times as are necessary until those concerned attain the required standard of proficiency. Practices should include vertical and oblique photographs of pin-points, straight runs of overlapping vertical photographs, and small mosaic photographs made up of a number of runs overlapping laterally. The standard which should be attained during the first year of training is given below. Advanced practices which necessitate a higher standard of skill may be laid down for trained pilots and air gunners with a view to meeting the special needs of different types of squadrons.

7. *Standard to be attained in first year.*

(i) *Pin-points.*

(*a*) *Vertical.*—In one flight, at a given height not below 2,500 ft., photograph successfully a number of pre-arranged pin-points. The number of exposures allowed should not be more than 50 per cent. greater than the number of pin-points. The standard of accuracy required is as follows :—

Focal length of lens used.	*Maximum permissible distance of subject from centre of negative.*
6-in. lens.	1 in.
8-in. lens.	1½ in.
10-in. lens.	2 in.

(b) *Oblique.*—In one flight at a height not above 1,000 ft., photograph successfully a number of pre-arranged pin-points. The number of exposures allowed should be not more than 100 per cent. greater than the number of pin-points. Standard of accuracy required:—Image must be perfectly sharp all over, and subject must appear not more than 1½ in. from centre of negative.

(ii) *Overlaps.*—In one flight, make an overlap of not less than twelve photographs along a road, railway or river, requiring at least two changes of direction. Standard of accuracy required:—The line of the objective must appear at least 1 in. from the edge of the negative at all points of the overlap. The amount of overlap must be between 30 and 70 per cent. in all cases.

(iii) *Mosaics.*—In one flight make a mosaic photograph of a given area which involves not less than three runs of six exposures each. Standard of accuracy required:—The whole of the specified area must be covered without gaps, and not more than three exposures may be outside the area. The amount of overlap must be between 25 and 75 per cent. both fore-and-aft and laterally.

8. Air practices should be carried out by pilots and observers, or air gunners, on different flights. A pilot and an air gunner should not both be allowed to qualify in any practice on one set of results only. On no account may airman photographers be employed in the air as camera operators in connection with training practices.

9. On completion of a photographic air practice those members of the crew of the aircraft who are concerned should proceed to the photographic section immediately after landing, fill up a reconnaissance report, and ascertain from the photography officer, or from the N.C.O. in charge, when the results will be ready. They should again visit the section at the time stated, when they will be shown the results and receive the criticism and advice of the photography officer. Pilots should invariably be shown the results of all photography carried out during their own flights, in order that they may see, and so be able to correct, any errors in their photographic flying.

Photographic Reconnaissance Reports.

10. Photographic reconnaissance reports are to be made out after all flights on which a camera is carried, whatever the object of the photography. A specimen report form is shown in Appendix I.

11. As soon as the aircraft has left the ground the photographer who fitted the camera will fill in the particulars required in para. 1. Immediately it lands the individual who took the photographs will complete para. 2, and the first four columns of para. 3, and will hand the report in to the photographic section together with the exposed plates or films. The remainder of the form will be filled in by the photography officer, and when the work has been completed and the results examined, the report will be filed for future reference.

12. Reconnaissance reports will invariably be required by I.L.O's and others under war conditions, and it is, therefore, very desirable that all concerned should become thoroughly accustomed to preparing them. In addition, they form a valuable record of tasks performed, and of the working of cameras.

Training Records.

13. A careful record should be kept in all unit photographic sections of the progress and results of photographic training. This may be done in a suitable manuscript book, such as S.O. Book 135, a separate page, or series of pages, being allotted to each individual, and full details of lectures attended, air practices attempted, etc., being entered therein.

14. Prints made from training negatives should be filed separately for each individual, the name of the person taking the photograph, date of exposure, and any other necessary details being marked on the back. Wallets, Probate (Sec. 14B, Ref. No. 291) form a convenient means of filing such prints.

Appendix I.
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APPENDIX I.

SPECIMEN PHOTOGRAPHIC RECONNAISSANCE REPORT.

(1) Unit.................................. Date..............

Camera No......................Focal Length..............

Exposure Setting.................. Aircraft No............

(2) Purpose for which photographs were taken, and approximate locality.

....

....

(3)

Exp. No.	Time.	Height.	Map Reference.	* Remarks of Photo Offr.	* Neg. No.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					

Remarks and signature of pilot..............................

....

Remarks and signature of camera operator....................

....

(4) General remarks of Photography Officer on the result of the work, and reasons for failure (if any).

....

....

....

....

If a training practice, PASS or FAIL........................

Signature...................

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* These columns to be filled in in the photograph section by those concerned.

Appendix II.
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APPENDIX II.

SYLLABUS OF AIRMENS' TRAINING AT THE SCHOOL OF PHOTOGRAPHY.

PRELIMINARY COURSE.

	No.	Subject.
First Week.	1.	The definition and history of photography.
	2.	The history and uses of air photography.
	3.	The nature and elementary principles of light.
	4.	The chemical action of light on silver salts.
	5.	The photographic plate.
	6.	The pin-hole camera, and the projection of an image.
	7.	The production of a negative.
	8.	The production of a positive from a negative.
Second Week.	9.	The laws of refraction.
	10.	The evolution of a lens.
	11.	Elementary lenses.
	12.	The projection of an image by a lens.
	13.	The S.1 Type camera.
	14.	Elementary camera manipulation.
Third Week.	15.	The iris diaphragm, its use, and calculations connected therewith.
	16.	Circles of confusion, focussing an image.
	17.	Loading S.1 type dark slides.
	18.	The theory and practice of exposure.
Fourth Week.	19.	Simple exposures.
	20.	The developer and fixer.
	21.	Practical development, fixing, washing and drying of exposed plates.
Fifth Week.	22.	Bromide printing-papers and methods.
	23.	The preparation of the dark-room.
	24.	Developing solutions for bromide papers.
	25.	Demonstration of contact printing.
	26.	Practical bromide printing.
Sixth Week.	27.	The enlarging lantern.
	28.	Enlarging condensers.
	29.	The focussing and sizing of enlargements.
	30.	Exposure in bromide enlarging.
	31.	Demonstration of bromide enlarging.
	32.	Practical bromide enlarging.
Seventh Week.	33.	Shading the negative.
	34.	Washing and hardening prints.
	35.	Preparing ferrotypes for glazing.
	36.	Glazing prints.
	37.	Rapid drying of prints.
Eighth Week.	38.	Intensification of negatives.
	39.	Reduction of negatives.
	40.	Photographing distant landscapes.
	41.	Photographing buildings.
	42.	Instantaneous photography.

Ninth Week.	43. The lighting and focussing of copies.
	44. Exposure in copying.
	45. Demonstration of copying.
	46. Practical copying.
Tenth Week.	47. The exposure and development of line negatives.
	48. Demonstration of the making of line negatives.
	49. The clearing of line negatives.
	50. Line negative formulae.
	51. Line negative making.
Eleventh Week.	52. Photographing interiors.
	53. Photographing apparatus, etc.
	54. Revision of preliminary course.
Twelfth Week.	55. " A " Test Examination.

ADVANCED COURSE.

Thirteenth Week.	56. The theory and design of camera shutters.
	57. The P.14 camera.
	58. The P.18 camera.
	59. The fitting of filters.
	60. Focussing by the parallax method.
Fourteenth Week.	61. The P.7 camera. (General description.)
	62. The P.7 camera body and lens cone.
	63. The P.7 shutter.
	64. The P.7 mechanism.
Fifteenth Week.	65. The fitting of cameras into machines.
	66. Focussing by the collimator method.
	67. The G.3 camera.
Sixteenth Week.	68. The F.8 camera. (General description.)
	69. The F.8 camera sight and method of using.
	70. The theory and use of electrical control of the F.8 camera.
Seventeenth Week.	71. The F.8 instrument box and shutter.
	72. The F.8 magazine and gearbox.
	73. The care of the F.8 camera accumulator.
	74. The fitting of the F.8 camera into machines.
Eighteenth Week.	75. Weights and measures.
	76. Royal Air Force formulae.
	77. Practical mixing of Royal Air Force formulae.
Nineteenth Week.	78. The theory of photo-chemical action.
	79. Exposures with ordinary plates.
	80. The development, fixing, washing and drying of ordinary plates.
Twentieth Week.	81. The theory of development of aerial negatives by dish, tank and factorial methods.
	82. The formation, influence and use of stain.
	83. The testing and loading of magazines and sheaths.
	84. The exposure and development of ordinary and panchromatic plates in the P.14 camera, with and without filters.
	85. The theory and practice of manipulation and sighting of P.7, P.14, and P.18 in the air.

Twenty-first Week.	86. Practical photography of pin-points from the air. 87. Practical development, fixing and drying of plates exposed in the air. 88. Practical tank and factorial development of plates exposed in the air. 89. The rapid drying of negatives.
Twenty-second Week.	90. The loading and unloading of the F.8 magazine. 91. The loading of the F.8 film on the developing and drying rotors. 92. F.8 chemical formulae. 93. Practical development, fixing, washing, drying and cleaning of F.8 film. 94. Failures, their cause, prevention and cure.
Twenty-third Week.	95. The plotting and identification of negatives. 96. The marking and registration of negatives. 97. Practical marking of negatives. 98. The filing, custody and storage of negatives.
Twenty-fourth Week.	99. The use of colour filters for air photography. 100. Demonstration in the uses of filters in outdoor photography. 101. Dispersion and colour absorption. 102. Demonstrations in the sensitivity of colour and non-colour sensitive plates.
Twenty-fifth Week.	103. Practical copying of coloured subjects. 104. Advanced practical copying. 105. Blue print copying.
Twenty-sixth Week.	106. The rapid production of bromide enlargements.
Twenty-seventh Week.	107. The rapid production of bromide enlargements. 108. Practical printing of F.8 film.
Twenty-eighth Week.	109. The theory of stereoscopic vision. 110. Demonstration in the making of stereograms. 111. Practical production of stereograms.
Twenty-ninth Week.	112. Lantern slide making from ground negatives. 113. Lantern slide making from line negatives. 114. Lantern slide making from negatives exposed in the air. 115. The optical lantern. 116. Practical projection.
Thirtieth Week.	117. Chromatic and spherical aberration of lenses, and how corrected. 118. Astigmatism and anastigmat lenses. 119. Experiments on the optical bench. 120. Lens formulae and calculations. 121. Types of lenses used in R.A.F.
Thirty-first Week.	122. Formulae for mosaics and overlaps. 123. Practical scaling and printing of overlaps. 124. Practical mounting of overlaps.

Appendix II.

Thirty-second Week.	125. Practical scaling and printing of overlaps and mosaics. 126. Practical mounting of overlaps and mosaics.
Thirty-third Week.	127. Practical scaling and printing of overlaps and mosaics. 128. Practical mounting of overlaps and mosaics.
Thirty-fourth Week.	129. The issue and storage of photographic stores. 130. Revision in bromide printing and enlarging.
Thirty-fifth Week.	131. General revision.
Thirty-sixth Week.	132. Revision in air cameras and air camera fitting. 133. Revision in developing, etc.

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APPENDIX III.

ALLOCATION OF DUTIES IN CONNECTION WITH AIR PHOTOGRAPHY.

1. The following instructions are promulgated for the guidance of officers and airmen employed on photographic duties.

2. *Duties of Area Photography Officer.*—(i) The area photography officer is responsible :—

(*a*) That the photographic work of the units and formations in the area or command is organised in accordance with the principles laid down in this Manual.

(*b*) That the programme of photographic training in the area or Command is prepared in accordance with the existing regulations, and that it is so arranged, in view of the prevailing circumstances, as to ensure that the required standard of proficiency is maintained.

(ii) He should act as technical adviser to the Air Officer Commanding in all matters relating to air photography.

(iii) His duties will be, primarily, of an administrative nature, but he will be required to possess a high standard of technical photographic knowledge, and should have considerable practical experience in air photography.

3. *Duties of Group Photography Officer.*—(i) The Group photography officer is responsible that the photographic work of the Units in the Group is organised in accordance with the principles laid down in this Manual.

(ii) He should act as technical adviser to the Group Commander, and will afford technical advice and assistance to the Units in the Group in all matters relating to air photography.

(iii) His duties will be both of an administrative and technical nature, and he will be required to possess a high standard of photographic knowledge and experience.

4. *Responsibility of C.O.*—(i) It is the responsibility of every Commanding Officer to ensure that the photographic section of the Unit, or Station, is efficiently organised, and that sufficient trained personnel is available for the work.

(ii) He should appoint an Officer to take charge of the photographic section; an Officer who has passed a short course at the School of Photography will be posted by the Air Ministry for this duty, if available.

(iii) Commanding Officers should inspect photographic sections at least once a week. During this inspection, special attention should be paid to the dark rooms, work rooms and equipment, and to the state of the photographic records.

(iv) The Commanding Officer is responsible that no improper use is made of the dark rooms, or of photographic equipment and materials. In no circumstances will work of a private nature be permitted in a section, nor will any privately owned cameras, equipment, or materials be allowed to be kept on the premises.

(v) The squadron, or station photography officer will advise his Commanding Officer on all technical matters relating to photography.

(vi) The Commanding Officer of every Unit is responsible for all photographic duties which involve flying, and should issue or approve all orders regarding the carrying out of photography in the air.

5. *Duties of Squadron Photography Officer.*—(i) In a squadron or independent Unit which possesses its own photographic section and personnel, the squadron photography officer is responsible to his Commanding Officer for the organisation and technical supervision of the work of the section. He will advise his Commanding Officer on all technical questions relating to photography.

(ii) He is responsible—

(*a*) For the organisation of all ground work in connection with photography, and for the discipline of the personnel.

(*b*) That the section is organised in accordance with the principles laid down in Air Publication No. 1354.

(*c*) That the marking, filing, and storage of negatives is carried out in accordance with the existing regulations, and that the records of photographs taken by the unit are kept in a proper manner and up-to-date.

(*d*) That all necessary cameras and equipment are held by the unit, and that such cameras and equipment are in a serviceable condition. For this purpose he will keep in close touch with the unit Stores Officer, and will co-operate with the latter, ensuring that all repairable cameras and articles of photographic equipment are returned to the appropriate depôt as soon as they become unserviceable.

(*e*) That the photographic organisation of the area, so far as it applies to the unit, is strictly adhered to.

(*f*) For the technical training of the personnel of the photographic section, and for the training of the flying personnel of the unit in performance of photographic duties in the air.

(*g*) That no improper use is made of the dark rooms, or of photographic equipment and materials. In no circumstances will work of a private nature be permitted in a section, nor will any privately owned cameras, equipment, or materials be allowed to be kept on the premises.

(iii) He should ensure that all photographic accessories in aircraft are fitted in the correct manner, and will co-operate with flight commanders in ensuring that any modifications to aircraft necessitated by new designs of cameras or equipment are carried out as and when ordered. He will investigate at once any camera failures, and will take steps to remedy any defects, or to return the camera for repair without delay.

(iv) He should inspect periodically all photographic equipment, particularly any which may be in stores and not in constant use. He is responsible that all stocks of chemicals and sensitive materials are stored in a place suitable as regards temperature, moisture, etc., and will advise the unit stores officer with regard to the best means of maintaining in good condition such stocks as are kept in a unit store.

(v) When a squadron is situated at a station where the photographic section is organised on a station basis, the squadron photography officer will only be responsible for the training of flying personnel of his own unit in photographic flying. Unless acting also in the capacity of station photography officer, he will not be concerned in any way with the organisation of the section and the conduct of the ground work.

6. *Duties of a Station Photography Officer.*—The duties of a station photography officer are precisely similar to those outlined above, with one exception. He should undertake the same duties and responsibilities as a squadron photography officer, except that he will not be responsible for the training of flying personnel of any of the units concerned.

7. *Duties of the N.C.O. in Charge of Photographic Section.*—(i) On the N.C.O. in charge depends, to a great extent, the successful operation of the photographic section. He must be familiar with stores procedure, the operation of all types of cameras and apparatus, all chemical processes employed, diagnosis of camera faults, and mosaic work. Although his duties consist primarily of supervision, he must be capable of performing, when required, any of the various classes of work carried out, and of detecting at a glance, the quality and faults, if any, of the results produced.

(ii) His general duties will normally be as follows. He is responsible for :—

(*a*) The discipline of all personnel employed in the photographic section.

(*b*) That each room of the section is staffed as economically as possible ; that an efficient system of relief for personnel working in dark rooms is adopted ; and that a quota of airmen is available, when required, for fitting cameras to aircraft, changing magazines, etc.

(*c*) For the cleanliness of the dark rooms and apparatus, and for the proper use of all equipment and material.

(*d*) That the photographic records are properly kept in the manner laid down in A.M.W.O. 526/26, as amended by A.M.W.O's 381 of 1927 and 463 of 1927.

(*e*) That the unit photography officer is informed when any fresh supply of equipment and material is necessary. For this purpose he will make a frequent check of the stock in hand.

(*f*) That all cameras and equipment are properly stored, and that any cameras and equipment issued for use in aircraft are returned to the section before the end of the day.

(*g*) Drawing up the daily roster of duties for the approval by the unit photography officer.

Appendix IV.
AIR PUBLICATION 1354.
(*Published March,* 1929.)

APPENDIX IV.

Index to Air Ministry Weekly Orders, Technical Instructions, King's Regulations and Publications relating to Photography.

(i) *Air Ministry Weekly Orders relating to Photography.*

Order No.	*Date.*	*Remarks.*
843.	1920.	Cancelled by 762 of 1928.
409.	1924.	Stores. Double allowance for AC. Squadrons during training season.
488.	1924.	Photographs of defects to be submitted with technical reports.
442.	1925.	Cameras at Units. Assistance of Specialist Officers for care and maintenance.

1. In order to ensure that all aircraft, navigational, armament, W/T., photographic and test instruments and apparatus on charge of units are maintained in an efficient condition, the following instructions are to be observed.

2. All the instruments that are fitted permanently to an aircraft are to be directly under the responsibility of the flight commander on whose charge the aircraft is held. Since, however, the flight commander may not have the technical knowledge necessary to supervise personally the repair and adjustment of instruments, he is, whenever the accuracy of an instrument is in doubt, to ask for assistance of the appropriate specialist officer.

3. Specialist officers trained in the care and adjustment of the instruments detailed below are to assist the flight commanders when called upon to do so :—

Photographic Officer .. Photographic Ground Apparatus Instructional Apparatus.

4. Repairs and adjustments of a minor order only to be carried out by units ; repairs and adjustments that are beyond the recourses of the unit are to be carried out by the appropriate stores depot as hitherto.

5. Stocks of spare instruments are to be held on charge as hitherto by the Stores Officer, and are on no account to be removed from the store except when required to replace an instrument that has become defective.

Order No.	*Date.*	*Remarks.*
526. amended by 381 & 463 of 1927 & 516 of 1928.	1926.	Negatives, marking, filing and disposal of, etc.
705.	1927.	Bromide paper, cases storage for. Use according to age, for operational or training work, demands from abroad.
461.	1927.	F.8 and ancillary apparatus, original issue of.
462.	1927.	Mountings, Universal, Adapters Type 3 and 4, modification of.
780.	1927.	Cameras, P.14 and P.18. Shutters are not to be replaced by Units.
80.	1928.	F.8 film spools, not to be retained. To be returned to No. 1 Stores Depot.
145.	1928.	Rubber straps for Adapters 3 and 4, of Universal Mountings. REF/14A/656.
313.	1928.	Anhydrous Chemicals. Containers. Tins to replace jars.

345.	1928.	Hypo. and Pot. Meta. 56 lb. kegs of crystal hypo. and 7 lb. tins of Pot. Meta. for Units with F.8.
446.	1928.	Cancelled by 827 of 1928. This Order supercedes T.O.41/1925, amended by 141/1925.
516.	1928.	Marking, storage, etc., of prints. Amended to 526/26.
620.	1928.	P.7 Type B. Introduction and issue to Day Bombing Squadrons.
716.	1928.	Instrument, shutter testing, issue to Depots.
762.	1928.	Prints, etc. Issue to other than R.A.F. Procedure. (Cancels 843/20.)
766.	1928.	Daylight Loading Slide. 14A/664 for P.14, and 14A/254 for P.18. The two are not interchangeable.
814.	1928.	Class " A " Stores. Disposal abroad.
827.	1928.	G/3 Camera Gun. Establishment.

(ii) *Technical Orders relating to Photography.*

Date.	*Book No.*	*Order No.*	*Remarks.*
1920.	41.	1374.	Camera tray L. and E. modification. (Obsolete.)
1920.	41.	1375.	Photographic light filters. (Check focus after fitting filter and after removing same.)
1920.	42.	1387.	Installation of LB cameras equipped with lenses fitted into suitable cones apertaining to their various lengths.
1920.	43.	1398.	Method adopted for collimating air cameras. (General.)
1920.	44.	1409.	LB Camera, 4 in. and 6 in. cone fitted DH.9a.
1921.	46.	1433.	Collimating air cameras. Amendment to 1398.
1921.	51.	1472.	The use of light filters in air photography, and tabular results of tests on light filters at I.D.E., Biggin Hill. (With illustrations.)
1921.	54.	1491.	Modification to LB Type Camera. (1) Guillotine Release. (2) Slide parallel plate dropping. (3) Runner Magazine. (4) Knob lever change over. (5) Bracket stiffening. (6) Lever slit adjustment. (With photo illustrations.)
1922.	60.	1542.	Alignment chart for lenses, formula and chart illustrating same.
1922.	68.	1609.	Endurance test on LB Type camera and shutter, photo illustration of roller blind shutter tapes. (Position of, etc.)
1922.	69.	1620.	Modification to LB Camera release lever to prevent kink occurring in the wire.
1923.	73.	1658.	Photographic plate carrier 5 in. × 4 in. of photo enlargers, modification to enable them to take plates 5 in. × 3⅞ in.

Appendix IV.

Date.	*Book No.*	*Order No.*	*Remarks.*
1923.	72.	1649.	Camera—method of excluding dust and sand. Photo illustrations. Since replaced by 14A/612.
1923.	81.	1725.	LB camera mod. shutter catch. (With illustrations.)
1925.	96.	Page 13.	Authority for altering handle on p.14.
1925.	3.	40.	Air cameras, focusing of. (All air cameras will be numbered on the body, lens, cone and tube, the same number on each to prevent interchanging. All air cameras will be focused by depots with a gelatine light filter inserted in the lens.
1926.	16.	171.	Mounting of Type G/3 camera. The yoke employed for mounting the Type G/3, camera gun ; it sometimes happens that the nut securing the bolt is rather a slack fit on the screw, this nut should be locked with a locking wire.
1927.	26.	141.	Apparatus for testing plate changing mechanism when on " power drive." (To enable the plate changing mechanism of the P.7 camera to be tested for power drive when on the bench, an apparatus has been designed which will be known as " Drive, Flexible, Hand Testing ") REF/14A/639 of A.P.1086.
1927.	27.	155.	Clips, lens, securing, for camera, aircraft, Type G/3. (To obviate any possibility of the lens of the camera, Type G/3, becoming lost while in the air, a clip, lens, securing has been designed and is now available at Stores Depot.)
1927.	32.	263.	Filters for use in the F.8 camera lenses. The following gelatine filters should be fitted between the components of F.8 lenses prior to their use in the air. Stores Reference—14/B/329. Filters, Light, Gelatine, Aviol.
1928.	36.	100.	Cameras. G/3 Modification. (i) To reduce time lag. (ii) Magazine Plunger.
1928.	36.	101.	Aircraft cameras. Maximum exposures.
1928.	39.	185.	Camera Gun Films Establishment. AMWO 446/28 cancels T.O. 41 and 141 of 1925.
1928.	41.	215.	Camera Mounting in Horsley.
1928.	42.	256.	P.7 in Virginia. Remote control.

(iii) *K.R.'s. & A.C.I's. Relating to Photography.*

	Para.
Accessories on Aircraft, responsibility for	639 (8)
Photographs of H.M. Ships	735
Specialisation—Officers of G.D. Branch	358
Trade Testing and Allied Trades of Airmen	A.P. 1112

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Appendix IV.

(iv) *Stores Regulations—A.P.* 830.

	Par
Repairs to photographic equipment	137
Storage instructions for photographic materials	Appendix xxx
Inflammable and dangerous stores—handling of	Appendix xi

(v) *Publications.*

Air Photography Part I	A.P. 1354	
,, ,, ,, II	,, 1355	
F.8.	,, 1224	
P.7	,, 79	(3rd edtn.)
P.14 and P.18	,, 808	(4th edtn.)
Camera Mounting	,, 913	(3rd edtn.)
Film developing apparatus for F.8 camera	,, 1229	
Photographic Contact printer for F.8 camera	,, 1228	
Interpretation of Air Photographs	,, 1113	
The Professional Papers of the Air Survey Committee. (War Offic		
Photography in A.C. Squadrons	Flying Training Manual.—Pt.	
Weights and spaces for Squadron Transport	Field Servi Pocket Book.	

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